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ART. XXV.—*On the Saliferous Rocks and Salt Springs of Michigan;* by ALEXANDER WINCHELL.

THE perfectly dish-shaped conformation of the strata of the lower peninsula of Michigan, has prevented the escape to the sea of such soluble substances as were originally embraced in the marine deposits from which the rocks were formed. Were there any point in the margin of one of these rocky basins, lower than its central portions, chance for escape of all its soluble contents would have existed; and it is doubtful whether in such case, brines could have been retained to the present day, in any considerable quantity. Our subterranean peninsular basins are comparable with the superficial basins in which the salt lakes of the world are located. Neither class of basins has an outlet. The basin of lake Superior was once filled with water as salt as that of the Great Salt lake. Both have received accessions of fresh water; but while one has been drained by an efflux which has continually carried away some portions of the chlorid of sodium, the other has been drained only by evaporation. The saliness of one has been reduced almost to an infinitesimal quantity;* that of the other is unimpaired, if it has not

* Given the time required for the efflux through the Straits of St. Mary, of a volume of water equal to the usual contents of Lake Superior; given also the minute percentage of chlorid of sodium still remaining in the water of the lake; it is required to determine how long the processes of dilution through meteorological precipitation and drainage through the Straits must have been continued to reduce the sea-water which originally filled the lake basin to the degree of weakness which it has now attained: disregarding the chlorids derived from the drainage waters flowing into the lake.

actually been strengthened by the loss of more water than it has received.

The subterranean basins of Michigan furnish us with three "great salt lakes." The principal one of these is shown, for the first time, in the "First Biennial Report" of the geology of the State (1860), to occupy a position between the Carboniferous limestone and the sandstones at the base of the Carboniferous system —being on a parallel with the gypsiferous formation of Nova Scotia. It is a mass of argillaceous, gypseous and pyritous shales, with thin beds of arenaceous and magnesian limestone, and beds of pure gypsum from eleven to twenty feet in thickness. The aggregate thickness is from 180 to 200 feet. Its outcrop describes an irregular circle, embracing the central portion of the peninsula. It underlies an area of 17,000 square miles, embracing the whole of 19 counties and at least half of 16 others. This assemblage of strata, though probably included in the American representation of the Mountain Limestone of the Old World, has received the local designation of Michigan Salt Group.

Seven hundred and fifty feet below this is the Onondaga salt group, the circuit of whose outcrop is traced from Monroe county to Galt in Canada West, thence to Mackinac island, Milwaukie and southward. The supply of brine in these strata has not been ascertained. They are well stocked with gypsum and are known to be saliferous.

The third saliferous horizon has but recently been recognized. It was indeed known that brine of feeble strength exists in the coal measures, but only within a few days has it been proved that the salt wells at Bay City and vicinity on the Saganaw river, are supplied from this source. It *might* have been known from the first existence of these wells, if those having the boring in charge could have been induced to preserve specimens of the rocks. The Parma sandstone below the coal measures is the reservoir of this brine, as the Napoleon sandstone beneath the Michigan salt group is the reservoir of the brine from this group. It is now known that the Bay City wells terminated at the bottom of the Parma sandstone though bored to nearly as great a depth as the wells of East Saginaw and vicinity, which pierce the Napoleon sandstone. This fact being established, a new well near Bay City has been sunk to a greater depth, and at 916 feet the Napoleon sandstone has been struck as predicted; and at the depth of 74 feet in this rock, brine has been brought up *completely saturated*. This occurrence, no less than the success of the first well bored in the valley, becomes a very gratifying confirmation of geological inferences drawn from observations extended over thousands of square miles, and in great part, hundreds of miles distant from the points where success has been attained.

When the first geological survey of the state was organized in 1837, Dr. Houghton, the superintendent, was instructed to direct his attention to the development of the "State salt springs." In pursuance of his investigations, and with the liberal coöperation of the legislature, he began, in 1838, two salt wells—one three miles west of Grand Rapids, and the other in Midland county on the Tittabawassee river. The latter, after being prosecuted at intervals for four years, had reached the depth of only 139 feet when the work seems to have been obstructed by a "quartzose" boulder. The Grand Rapids well was sunk 473 feet but without success. In the mean time Hon. Lucius Lyon of Grand Rapids sank a well 661 feet at a point further east; and, obtaining water about one-fifth saturated, succeeded in manufacturing salt for a few years, at a time when salt was selling for $3.00 per barrel.

The cause of these early failures is now apparent. Dr. Houghton entertained erroneous views of the structural geology of the peninsula. He expressed the opinion (Report, 1839, p. 9) that the strike of the rocks was northeast and southwest across the peninsula—that Saginaw bay occupied a denuded space along the outcrop of "the sandstone" just where it comes in contact with "the limestone of the north"—that the coal on the Illinois river was on the strike of the coal-bearing rocks of Michigan—and the galeniferous limestone of Wisconsin and Illinois a prolongation of "a portion of the rock formation in the northern part" of Michigan. He further supposed that the brines of the state rose to the surface through fissures in the strata overlying the salt rock (Rep., 1838, p. 21; also special Rep., 1839, pp. 2 and 3), and that the geological positions of the state wells on the Tittabawassee and Grand Rivers were about the same (Spec. Rep., 1839, p. 6); while the latter was at least 360 feet below the former and separated from it by the whole thickness of the coal measures (see also Hubbard's Geol. Rep., 1841, pp. 132, et seq.).

It now appears that while the well on the Tittabawassee was located far within the salt basin, that on the Grand River was upon the thinning out edges of the strata. The brine at the latter point, as well as in Macomb and Washtenaw counties is caused by a sort of exudation over the rim of this basin, and does not rise through fissures from a deeply seated rock.

When it became apparent that the deepest portion of the great salt basin was probably beneath the neighborhood of the confluence of the Cass, Shiawassee and Tittabawassee rivers, a boring was commenced at East Saginaw, which at 742 feet had passed through the Coal measures, Carboniferous limestone and Napoleon sandstone, and afforded a plentiful supply of brine nine-tenths saturated. This success was the signal for a general

onset; and within two years, twenty-three wells have been bored along the valley of the Saginaw, and new ones are continually undertaken.

The following is an average section of the rocks passed through in the borings in the vicinity of east Saginaw:

Alluvial and Drift materials,	100 ft.
"Woodville sandstone," brown and coarse,	65 "
Coal measures, consisting of shales with some sandstones and limestones and coal,	130 "
"Parma sandstone" white and porous,	115 "
Carboniferous limestone, often highly arenaceous; generally so below,	75 "
"Michigan Salt Group,"	170 "
"Napoleon sandstone," light buff, rather coarse and porous,	110 "
Total,	765

The Napoleon sandstone is underlaid by a red shale which has been pierced 64 feet.

From East Saginaw the depth of the wells increases southward, toward the center of the general basin; and also northward, so that in the vicinity of Bay City the bottom of the Napoleon sandstone is found at the depth of 1000 feet. We seem therefore to have a local basin toward the mouth of the Saginaw river, although the vicinity is ten or fifteen miles nearer the outcropping margin of the salt basin, which is found at the mouth of the Pigeon river and in Tawas bay, on opposite shores of Saginaw bay.* This local basin is filled by an extraordinary thickening of the shales of the Coal measures, almost exclusively. As the Parma sandstone, which furnishes the brine of the first wells at Bay City, is probably the equivalent of the saliferous "Conglomerate" of Ohio, it seems that the supply of brine at this horizon, bears a relation to the thickness of the overlying shales of the Coal measures. It also suggests that in the deeper portions of the general basin, the Coal measures must be found similarly augmented in thickness, and the Parma sandstone similarly charged with brine. This condition should be looked for, west and northwest into Gratiot and Midland counties.

The following are analyses of Saginaw valley brines. The first is by Prof. DuBois of the University of Michigan, from the Napoleon sandstone; the second by Jas. R. Chilton & Co., from the Parma sandstone.

* On page 72, vol. i, Geolog. Rep. Wisconsin, Prof. Hall states, undoubtedly through inadvertence, that the "Hamilton group is known upon Saginaw bay." The Hamilton group strikes the lake shores in Thunder and Little Traverse bays many miles further north.

	Saginaw City.	Bay City.
Specific gravity,	1·180	1·163
Chlorid of sodium,	19·246	19·692
" calcium,	2·395	0·742
" magnesium,	1·804	0·432
" potassium,	0·127	
Sulphate of lime,	0·534	0·145
" soda,		0·116
Bromid of magnesium,		0·013
Compounds of iron,	0·064	
Total solid matter,	24·170	21·140

The difference in the composition of these brines is in accordance with their difference of origin.

The average supply of the Saginaw wells is at least 25,000 gallons each, in 24 hours.

The creation of this new branch of local industry is destined to become a matter of very great general importance. Although but two years have elapsed since the production of the first bushel of salt in the Saginaw valley, there are now (Aug. 1st) no less than 22 blocks of kettles in actual operation, turning out 1210 barrels of salt per day, or, making an allowance for the effect of winter weather, 1,980,000 bushels per year. Here is a growth, at the end of two years, equal to that attained by the Onondaga Saltworks in 1834, at the end of 38 years after the salt springs passed under the superintendence of the State. In two months, seven more blocks will come into operation, increasing by nearly one third, the foregoing figures.

Such is the strength and abundance of the brine and cheapness of fuel, that a barrel of salt is made at a cost of 64 cents. The cost of a barrel at Syracuse is at least 95 cents, so that Saginaw salt would pay the manufacturer 48 per cent of profit if the price were put down to the prime cost of the article at Syracuse. Moreover the quality of the article has proved so superior, that the market is actually clamorous for an adequate supply.

When we consider the cheapness and quality of Saginaw salt, the inexhaustibleness of the supply of brine and the excellent facilities for shipment, it would appear that there is little danger of over estimating the future development of this new resource.

University of Michigan, Aug. 4, 1862.

ART. XXVI.—*On the Perception of Relief;* by Prof. EDWIN EMERSON, of the Troy University.

PROF. CIMA, of Turin, has sent us the description (says the editor of the Cosmos) of a stereoscopic experiment which is not without interest. He takes the picture of a front view of a human head, executed either in crayon or lithograph or copper-plate, and which is three or four centimetres in height; this he cuts into two parts along a line which coincides with the vertical axis of the nose; he takes one of these halves in each hand, and holding them in the same perpendicular plane, he brings them before the eyes at a distance which is less than that of distinct vision; he then allows the optic axes to converge, and thus causes the drawings to approach or recede until he is able to see two pictures of each half, and until the two middle ones overlap, so that they make the impression of an entire countenance. When one makes this experiment for the first time, says Prof. Cima, he will see with astonishment that the full face which is produced by the overlapping of the two halves makes, in a high degree, the impression of a solid body; the half tones melt and mix together as in a modelled figure; the nose rises well from the face; the eyebrows, lips and chin stand out very well; and the entire figure raises itself from the ground upon which it is drawn, and assumes, in a remarkable degree, a living expression. The necessary distance of the two half-pictures from each other and also the proper distance from the eyes of the observer for the production of the greatest effect, can only be ascertained by trial. The more steadily one gazes at the pictures, the more the sensation of relief is strengthened."*

The foregoing extract from *The Cosmos* has been reproduced in *Pogg. Annalen*, bd. cii, p. 319; in *Il Nuovo Cimento*, vi, 185; in *Die Theorie des Schens und räumlichhen Vorstellen*, bei Dr. Cornelius, Halle, 1861; and in *Monographie du Stéréoscope*, par Blanchère, Paris, 1862. Seemingly endorsed by such a high authority as Moigno, the alleged fact passes through scientific treatises unquestioned, and is now apparently regarded as established. We consider it, therefore, important to refute the conclusions involved in the experiment as described by Prof. Cima, and at the same time point out some analogous mistakes as to the perception of relief.

When the experiment of Prof. Cima is carefully performed and analyzed it will be found that the right eye sees the right half of the middle picture, and the left eye the left half, now as these two dissimilar masses are not superposed upon each other, as is the case with the dissimilar complementary figures in ordi-

* Cosmos, pp. 353, vol. ii.

nary vision, but are merely joined together at the line passing through the centre of the resultant picture, it is evident that if such an effect is realized as that "the nose rises well from the face" or that there is any "sensation of relief," we have here an experiment which refutes the established theory of binocular vision, and leaves the effects of the stereoscope without any adequate explanation.

The fact is, however, that in Prof. Cima's experiment there is no real perception of relief. All that is really seen is the perspective, which is mistaken for relief or solidity. To prove this —let the observer, while looking at the two half-pictures in the mode alledged to produce the effect of solidity, close one eye, the right for instance, the right half of the picture disappears, but the left retains exactly the same appearance it had before; it loses no appearance of solidity simply because it had none. Or, let the observer join the two halves together and closely and continuously observe them with one eye, the effect will be the same as in Prof. Cima's experiment. Or, to vary the test, take a *single* photographic picture, for instance the right hand side of a stereograph, cut it in two by a vertical line through the centre and place the halves the proper distance apart in a stereoscope, so as to unite them readily into a whole, the same effect, claimed by Prof. C. to be a sensation of relief will be observed: that it is not relief will be most manifest by comparing it with a stereograph of the same scene.

But the reader will very naturally inquire—'How did Prof. Cima, and those who have unquestioningly quoted his experiment fall into this error with regard to the presence of relief?' This reasonable question we will endeavor now to answer.

The ability to perceive relief, or solidity, is a natural one. To those who have the proper use of their eyes, and can walk, it is an intuitive faculty, we cannot help seeing solidity, where it exists, if we try, no more than we can help hearing sounds or seeing colors. The common idea that this faculty is the *result* of experience and is, therefore, acquired, is opposed by the whole analogy of our being. The infant does not learn to hear; it hears, it hears intuitively, if it is a perfect child, but learns as it grows to know what it hears; it feels a blow but may be too young and feeble to know what that blow is; so it has but to open its eyes and the scene enters, it is painted properly and instantaneously upon the retina, but it may require a long education before the child will have an intelligent idea of what it sees; indeed it may go through life and never be able to give more than *one* name to a great variety of very different colors, such as red, vermillion, scarlet, orange and crimson. It is unphilosophical to confound a faculty with its use. We have the natural faculty of seeing solidity; but the acuteness with which it is

employed, depends greatly upon the intelligent attention with which it is exercised.

It is no answer to this to say that we can analyze the optical conditions upon which the perception of relief depends. This has been splendidly done by Wheatstone, Dove, and others, and is beautifully illustrated by the stereoscope; but this has no necessary connection with the question before us. When I say—we hear intuitively—it is nothing, in the way of refutation, to explain to me the acoustic conditions upon which hearing depends, or to assert that Mozart had no intuitive perception of melody or harmony because the laws are fixed by which a melody ought to proceed, and harmony, to be such, must be according to the formula of Thorough Base, whereas the child Mozart could not know all this. So with the matter in question; all men see solidity who have the proper use of their eyes; very few indeed know how it is effected, or are able to distinguish acutely between the perception of binocular relief and the perception of mere perspective, or the appearance of distance without relief.

The perception of *relief* depends upon the angle formed by the rays which proceed from any object of sight to the right and left eyes respectively; the larger this angle the more relief is apparent, provided the eyes can unite the dissimilar images; but when by reason of distance this angle becomes nothing, practically, and the rays are parallel as they enter the eyes, relief vanishes.

The perception of the *perspective* depends upon very different conditions, such as the direction of the lines that compose a view, the light and shade, the apparent size, the tint, &c.

When we consider the matter it is not surprising that these two modes of perception should often be confounded. True relief diminishes so gradually, and melts so gently away, leaving perspective entirely master of the field, that the essential difference between them is likely to be lost sight of. That this is the case may be shown by the following examples:—

It requires a series of very careful experiments to determine how far, under ordinary conditions, we can perceive relief. Experiments of my own lead me to believe that the distance is under three hundred yards. The only reason a good painting, whose foreground is represented as it appears at the distance of two or three hundred yards, is not a complete illusion when seen under favorable conditions, is, that we can change our point of view; and motion to one side or the other will impart the idea of relief in nature, but as there is no relief, properly so-called, in a painting, as soon as we shift the point of view, we detect this and the illusion is at an end. Hence, paintings ought to be observed by one eye, and from one point of view to obtain the

maximum effect. Hence, also, stereographs of scenes which lie at a distance of over three hundred yards from the observer will give no stereoscopic effect, will not *give the impression* we are able to get with our eyes, assisted by our capacity to move from one point of view to another; they ought, therefore, to be photographed from stations more or less distant from each other, but always exceeding considerably the distance between the eyes.

Persons *not accustomed* to experimenting with the stereoscope cannot distinguish readily between stereoscopic and pseudoscopic effect; they are also constantly imposed upon by views which have no stereoscopic effect whatever; I have repeatedly mounted two identical or right-eye views of the same scene, side by side, as though they were right and left eye views and have never failed to get the verdict that they exhibited stereoscopic effect; which was impossible, of course. Not only are ordinary observers thus mistaken, but they constantly manifest an opposite peculiarity, being unable to see the greatest relief when it is exhibited in an unusual manner. In *Das Stereoscop*, C. G. Ruete, Leipsig, 1860, Dove's illustration of this point is republished in such a way as to destroy the object in view, showing that his commentator had not a fine perception of relief.

A remarkable instance of the uncertainty attending the perception or non-perception of stereoscopic relief, even in cases where we might suppose there could be no want of knowledge is shown by the controversy now going on in Europe over *The Chimenti pictures.* Sir David Brewster thinks he has in these pictures a specimen of real stereoscopic drawings produced about the middle of the 17th century; and this opinion is endorsed by Prof. Tait, Prof. M'Donald and others in decided terms. I have made a careful examination of the photographs of these pictures, and the truth is that the trifling stereoscopic and pseudoscopic qualities about them are evidently accidental. To prove this let any one execute a pen-and-ink sketch; and then let him make as perfect a copy of it as he can without careful measurements; now place these two drawings in the stereoscope and you get the same kind of effect seen in the Chimenti drawings, and for the same reason; the drawings will vary more or less from each other; all that is necessary then to impose upon ordinary eyes, is to find out which way the sum of the variations preponderates; mount the drawings accordingly, and, mirabile dictu! you have produced a stereoscopic picture (the pseudoscopic portion being overlooked) drawn by hand; you have done that very thing that Sir David Brewster has repeatedly declared was quite beyond human skill! If Prof. Wheatstone gets no heavier blow than this, his fame as a discoverer is secure.

As a further confirmation of our views, we may point to the fact that but few persons can properly locate the optical position

of reflections from curved surfaces, and, in particular, the images from concave surfaces.

During the last year or two large assemblages have been drawn together in our principal cities, to see with delight the effects produced by what is called *the Stereopticon*, which is merely another name for a Magic-lantern of good quality, with *one* side of a glass stereograph for a slide. Nearly all in these large assemblages have agreed in believing that they saw, what they were told they saw, excellent stereoscopic effect in the single picture which alone is exhibited. The truth is they made the popular mistake; they saw nothing but perspective.

Stereoscopic effect on a large scale may be obtained by exhibiting the right and left pictures of a glass view side by side, by the magic-lantern, and then uniting the magnified pictures by means of prisms. This I have recently demonstrated by experiment. The idea was also suggested some years ago, by Dr. Wolcott Gibbs to Mr. Pike, of New York, but not put to the test.

We conclude, then, from the foregoing—

1. That Prof. Cima's experiment is only another instance showing how easily we can mistake one thing for another, and induce others to do the same.

2. That intuitive perception of relief may be indefinitely increased in degree by exercise; showing that this sense follows the same law under which we employ our other faculties.

ART. XXVII.—*On the relations of Death to Life in Nature;* by J. D. DANA.*

1. THE creation of a plant with "seed in itself," as Moses states in his concise description, was the simultaneous institution of life and death. It was the establishment of an incoming and outgoing stream, to be in constant flow as long as the kingdoms of life should last—an incessant renewal of youth, and rejection of age.

All life is a system of progressing change in cycles—the germ first, then the embryo, the young, the adult, and last, the seed or germ again, to continue the rounds; the adult sooner or

* From a paper on the Anticipation of Man in Nature, published in the New Englander, for May, 1859. Views similar to those here given on stored force in plants were presented to the American Association in Aug., 1859, by Prof. Joseph LeConte, and published in this Journal for Nov. of that year, vol. xxviii, p. 305. As Prof. Dana's paper is prior in date, he will not be charged with copying the views (which we doubt not were independent,) of Prof. LeConte. The paper of Prof. Henry, in vol. xxx, p. 32, also contains some views bearing on the subject. This paper is here republished, not because of any novelty in the thoughts, since they are in the main well understood among scientific men, but from a desire to spread a knowledge of the relations of death to life beyond the pale of science.—EDS.

later disappearing from the field of progress, and then from the sphere of existence. Death is implied in the very inception of the scheme.

2. Death is also in every step of the process of life. For the living being is throwing off effete matter during all its growth; the change is constant, so that with each year a large part of the material in our bodies has passed away and been replaced by new. Moreover, the force which had been expended in making a cell, or particle of tissue, goes to form a new cell or particle when the former dies, and was needed for the new formation going on. Force is not lost or wasted, but used again. There is unceasing flow, and in this flow is life; its cessation is death.

3. The kingdom of plants was instituted to turn mineral matter into organic, that the higher kingdom of animals might thereby have the means of sustenance; for no animal can live on mineral matter. Now this living of animals on plants implies the death of plants.

Again, the rocks of the globe are, to a great extent, made of the remains of dead animals.

4. The chemistry of life, also, required death. Life in the plant or animal if sustained by means of nutriment, and continued consuming, with no compensating system, would evidently end in an exhaustion of any finite supply. A perfect adjustment was therefore necessary, by which nutriment should sustain life, and life contribute to nutriment. Now the plant takes up carbonic acid from the atmosphere, appropriates the carbon, and gives back the oxygen. Yet there is no tendency to an exhaustion of the atmospheric carbonic acid, or an over-supply of the oxygen; for death strikes an exact balance.

The death of the plant ends in a change of all its carbon into carbonic acid again. Thus the plant, as it grows, decomposes carbonic acid to get carbon, and then ends in making, by its decay, as much carbonic acid, and restoring it to the atmosphere. Thus, through death the compensation is perfect. The atmosphere loses only what it receives. Again, as just now observed, the plant, in growing, gives oxygen to the atmosphere; but in the decay of the plant, the carbonic acid formed is made by taking up the same amount of oxygen. The same carbon that lost oxygen when becoming a part of the plant, takes it again at the decay. The system is hence complete. The parts play into one another in perpetual interchange. Take death and decay out of the sytem, and it would not work.*

* In early geological history, as is generally believed among geologists, there was an excess of carbonic acid in the atmosphere; and this excess was removed to a great extent, by the growth of plants during the Carboniferous era. Vegetable material decaying under water does not undergo complete decomposition, and thus part of

Animal life, as above stated, was made to subsist on plants. But the scheme is so well managed as not to disturb the balance made by the vegetable kingdom alone. For all the carbon of animals comes from plants. The plants which feed an animal, and which, on decay, would have turned into carbonic acid, become changed into carbonic acid in the course of the growth of the animal, so that the whole amount of carbonic acid which the animal makes, is only what the plants would have made if left to natural decay. Thus the higher kingdom of life is introduced and sustained, and yet the balance remains undisturbed. The system is perfect.

5. Again, one part of the animal kingdom, through every class, is made to eat up the other part, or at least live on it. The flesh-eaters are of all grades, low and high, from the infusorium and maggot, to the lion and man. Some take what is already dead or decomposing; others kill and eat. On this subject we observe:

(1.) Death is in the system of nature—death from earthquake, lightning, and all moving forces, as well as by natural decay; and the creation of carnivorous animals was hence in harmony with the system.

(2.) Various noxious animals are held in check by the carnivorous species.

(3.) By means of flesh-eaters, the diversity of animal species subsisting on a given amount of vegetation is vastly increased, and a wider expansion is given to the animal kingdom.

(4.) Putrefaction of the dead is prevented by a multitude of scavengers. who at the same time turn the flesh into food for the vegetable kingdom; and thus plants feed animals, and animals feed plants,—one of nature's circles again.

The last two principles mentioned are of profound importance. The vegetable kingdom is a provision for the storing away or magazining of force for the animal kingdom. This force is acquired through the sun's influence or forces acting on the plant, and so promoting growth; mineral matter is thereby carried up to a higher grade of composition, that of starch, vegetable fibre and sugar, and this is a state of concentrated or accumulated force. To this stored force animals go, in order to carry forward their development; and moreover, the grade of composition thus rises still higher, to muscle and nerve, (which contain nitrogen in addition to the constituents of the plant,) and this is a magazining of force in a still more concentrated or condensed state.

the carbon is left behind; and so far as there is carbon left, there is an actual abstraction of carbonic acid from the atmosphere, by the process of growth. The Coal-era was a period of great marshes; and by this means the needed purification of the atmosphere was effected, preparing it for land life. The amount abstracted now by the same means is very small, and may be balanced by the carbonic acid from mineral sources and volcanoes.

There are thus five states of stored force in nature—three in the *inorganic*, the solid, liquid, and gaseous; and two in the *organic*, the vegetable and animal.

Now what is the provision to meet this last and highest condition? Is this magazined force left to go wholly to waste by the death and decomposition of the plant-eaters? Just the contrary: an extensive system of flesh-eaters was instituted which should live upon it, and continue it in action in sustaining animal life among successive tribes. The flow is taken at its height, and the power is employed again and again, and made gradually to ebb. What is left as the refuse is inorganic matter—the excreted carbonic acid, water, and excrements, with bones or any stony secretions present. Thus the flow starts at the inorganic kingdom, and returns again to the inorganic. Moreover, in the class of quadrupeds, (mammals,) the flesh of the herbivores (cattle) is among the means by which the animal type is borne to the higher grade of the carnivores. The true carnivores, besides, take the best of meat. Whales may live on the inferior animals of the sea; but the large forest flesh-eaters take beef and the like.

There is another admirable point in this scheme. The death and decomposition of plant-eaters would have rendered the waters and air, locally at least, destructive to life. It is well known that it is necessary in an aquarium to have flesh-eaters along with the plant-eaters and plants. And when in this way the living species are well balanced, the water will remain pure, and the animals live on indefinitely. If not so balanced, if an animal is left to decay, the waters become foul, and often everything dies. Putrefaction and noxious chemical combinations follow death, because, in life, the constituents, carbon, hydrogen, nitrogen, and oxygen, are in a constrained state, at the furthest remove from what chemical forces alone can produce; and hence, when the restraint is taken off at death, the elements fly into new conditions according to their affinities. Now animals, dying yearly by myriads, are met at death by an arrangement which makes the dead contribute anew to animal life as its aliment, and in this very procees the flesh ultimately comes out innocuous, and is at last so far changed to the inorganic condition as to be the best of fertilizers for plants. Part of the process of getting rid of the great fleshy carcasses, consists in their minute subdivision by the feeding of larves of insects, and, further, an infinitesimal division of the insect as the food of the infusoria,—which again may become the nutriment of larger animals, to go the rounds once more. But the final result is, as stated, *plant-food*—largely through the processes of digestion and excretion, but part through the decomposition of animals that are too small and readily dried up to prove offensive.

Thus the carnivorous tribes were necessary to make the system of life perfect.

One word respecting the necessity of a check on the excessive multiplication of individuals. Nature, as just now observed, is a system of constantly varying conditions—of changing seasons, winds, clouds: of inconstancy, under law, in all forces and circumstances. At the same time, the growth of a species requires the nicest adjustment of special conditions in each case. On this account the reproductive powers in species is in many cases excessively large, so that the various accidents to which the eggs or young would be exposed, might not cause their extermination. This provision opened the way for occasional excessive multiplication, and required a check from carnivorous races.

6. Finally, could death be prevented in a system of living beings in nature without constant miracle? How should the earth be managed to secure it against death? It would be necessary to still the waves, for they are throwing animals and plants on the coast to die; to still the winds, for they are ever destroying in some parts of their course; to still even the streams and rains. With winds and waves, not only helpless animals and plants, but men's houses, ships, and boats, would now and then be destroyed, in spite of prudent precaution and holy living. But if we still the waves, the winds, and the streams, the earth would rot in the stagnation, and here again is death!

We thus learn, that in life the fundamental idea of reproduction implies death; the processes of life are the processes simultaneously of death; the stability of the system of life requires death; the vegetable kingdom is made to feed animals, and the animal kingdom, while containing plant-eaters, demands flesh-eaters for its own balance, for the removal of the dead, and to make out of dead flesh the proper food for plants, thus to pay its debt to the vegetable kingdom. Hence death pervades the whole system of life in its essence and physical laws; and it could not be prevented in a world of active forces except by a constant miracle; and this would be an annihilation of nature, that is, of a system of law.

ART. XXVIII.—*On the Carbonates of Alumina, Glucina and the sesquioxyds of Iron, Chromium and Uranium;* by THEODORE PARKMAN, Ph.D.

THE precipitates, produced by the alkaline carbonates in solutions of alumina, glucina and the sesquioxyds of iron, chromium and uranium, have been investigated by a large number of observers; but their results are so discordant, that the true composition of the substances in question is still in doubt. The following investigation was undertaken at the suggestion of Prof. Charles W. Eliot, under the idea that the contradictory results, obtained by previous writers, may have been owing to a loss of carbonic acid, during the processes of washing and drying. This would be probable enough in itself, from the weak affinities of both acid and base, in each case, and is, I think, fully confirmed by the analyses which follow.

1. *Carbonate of the sesquioxyd of iron.*

Fe_2O_3, CO_2.

The precipitate, formed by mixing carbonate of potash with nitrate of the sesquioxyd of iron, after washing with cold water, consists, according to Gmelin,* of hydrated sesquioxyd of iron, free from carbonic acid. Berzelius† considers that the compound Fe_2O_3, $3CO_2$ is formed, but that it exists only momentarily. Langlois‡ gives an analysis of a precipitate, produced by carbonated alkali in a sesqui-salt of iron, perfectly freed from alkali by washing and dried at 100° C. His results were 88·47 p. c. Fe_2O_3, 10·17 HO, 1·36 CO_2, from which he does not deduce any formula. Wallace§ finds the precipitate by carbonate of soda in sesquichlorid of iron, after drying over sulphuric acid, to be $3Fe_2O_3$, CO_2, 6HO: in the nitrate, $9Fe_2O_3$, CO_2, 12HO. According to Barratt,‖ the precipitate produced by carbonate of soda in sesquichlorid of iron, when dried in the air, has the formula $3Fe_2O_3$, CO_2+8HO; when dried at 100°, $3Fe_2O_3$, CO_2+4HO.

The carbonate of iron which I have examined was precipitated, at the ordinary temperature, from pure crystallized iron-potash-alum by carbonate of soda in slight excess. The precipitate was not washed or dried, but simply pressed between folds of porous paper, under a heavy weight, for about twelve hours, and while still moist, introduced into a bulbed tube of hard glass, and the whole weighed. It was then ignited in a slow stream of

* Handbook of Chem., v, 222.
† Lehrb. der Chem., iii, 626.
‡ Ann. Chim. et Phys., xlviii, 502.
§ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.
‖ Chem. News, i, 110, in J. pr. Chem., lxxxii, 61.

dry air and the water caught by a weighed chlorid of calcium tube. The loss of weight in the bulbed tube and substance, minus the increase of weight in the chlorid of calcium tube, would give the weight of carbonic acid corresponding to the carbonate of iron, while the carbonate of soda and sulphate of soda would remain unchanged. The sesquioxyd of iron, remaining in the bulb, was washed and weighed. Of course, by this method, the water cannot be estimated, which, according to all previous observers, exists in all the carbonates in question. In my first analyses the substances, though not washed, were dried over sulphuric acid: but three analyses of the same substance, which gave successively the percentages of carbonic acid, 15·74, 14·45 and 12·95, showed conclusively that the substance lost carbonic acid by standing. All the other analyses made, both of this and of the other carbonates, were therefore made with the precipitate, while still moist. The formulas obtained, therefore, express simply the relation between the acid and the base, and a certain amount of water must probably in every case be understood. In every case, more than one preparation was analyzed, to ascertain whether the precipitate had always the same composition.

Of the carbonate of iron four analyses were made, with the following results:

	Calculated.		Preparation I.	Prep. II.	Prep. III.	
					1.	2.
Fe_2O_3	80	78·43	79·88	79·47	79·09	80·52
CO_2	22	21·57	20·12	20·53	20·91	19·48
	102	100·00	100·00	100·00	100·00	100·00

Considering the ease with which the substance loses carbonic acid, the above results agree with the calculated percentage probably as closely as could be expected—closely enough, at any rate, to fix the composition of the substance with sufficient certainty.

2. *Carbonates of the sesquioxyd of chromium.*

$Cr_2O_3, 2CO_2$

Cr_2O_3, CO_2

The earliest analysis of carbonate of chromium is by Meissner,* who found it to contain 77·30 Cr_2O_3, 15·54 CO_2 and 7·16 HO. Meissner's analysis, however, is quite untrustworthy, as may be seen from his details of it. According to Lefort† the precipitate by carbonated alkalies in the violet salts of chromium is Cr_2O_3, CO_2+4HO; in the green modification only the hydrated oxyd. According to Langlois,‡ the precipitate by carbonated alkalies in the salts of chromium, dried at 100° C., is Cr_2O_3, CO_2+Cr_2O_3, 6HO. Wallace§ precipitates sesquichlorid of chromium by car-

* Gilbert's Annalen der Physik, lx, 366.

† Compt. Rend., xxvii, 269.

‡ Ann. Chim. et Phys., [3] xlviii, 502.

§ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.

bonate of soda, in very dilute solution, and dries the precipitate over sulphuric acid. His results give the formula Cr_2O_3, CO_2, 4HO. Barratt* proceeds in the same way as Wallace and obtains the same result, which is also that obtained by Lefort.

The substance which I analyzed was precipitated by carbonate of soda, in slight excess, from crystallized chrome-potash-alum, free from iron and alumina. In the first analysis, given below, the substance was dried over sulphuric acid: in the others not. The first analysis was made like those of carbonate of iron. The wash-water from the oxyd of chromium, left in the bulbed tube after ignition, was colored yellow from alkaline chromate. This must have arisen from oxydation of a little oxyd of chromium, by ignition in the air in contact with alkaline carbonate. The solution was reduced by hydrochloric acid and alcohol, precipitated by ammonia, and the oxyd of chromium thus obtained added to the rest. There still remained an error, however, from the chromic acid having driven out carbonic acid from the carbonate of soda; and to avoid this, the other determinations were made in a stream of hydrogen. In this latter method there would be a possible source of error, viz., a reduction of the alkaline sulphate to sulphid. This, however, was extremely small, as the wash-water, on heating it with hydrochloric acid, gave off in every case only a trace of sulphuretted hydrogen and either remained clear, or became only very slightly milky, from precipitated sulphur.

The analyses of a large number of preparations gave the following results:

			Prep. I.	Prep. II.		Prep. III.		Prep. IV.		Prep. V.	
	Calculated.			1.	2.	1.	2.	1.	2.	1.	2.
Cr_2O_3	77·4	63·76	66·81	66·51	66·89	67·53	66·59	73·03	73·44	72·55	73·84
$2CO_2$	44·	36·24	33·19	33·49	33·11	32·47	33·41	26·97	26·56	27·45	26·16
	121·4	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

The composition of the first three precipitations comes pretty near the formula, given above, while the other two vary largely from it. These two were made in summer, while the others were made in cold weather, and it is possible that there may have been a greater loss of carbonic acid at the higher temperature. I am inclined to think, however, that this is not the case, as, in the last preparation, the liquids were cooled, before precipitation, and the precipitate left to press in a refrigerator, containing ice. It occurred to me that one cause of the varying composition of the precipitates might be that basic compounds might at first go down, before the carbonate of soda was in excess, as is the case, for example, when ammonia, not in excess, is added to solutions of copper. To ascertain whether this was the case, an analysis was made of a precipitate, produced by pouring chrome

* Chem. News, i, 110, in J. pr. Chem., 82, 61.

alum slowly into carbonate of soda, with constant agitation, until the alkaline reaction became comparatively feeble. In this way there would be always an excess of carbonate of soda present. Two analyses were made of the same preparation.

	Calculated from Cr_2O_3, $2CO_2$.	I.	II.
Cr_2O_3.	63·76	65·03	64·96
$2CO_2$.	36·24	34·97	35·04
	100·00	100·00	100·00

This seems to prove pretty conclusively that there is a carbonate of chromium, possessing the above formula, and that the precipitate produced by the alkaline carbonates consists chiefly of it, generally mixed, however, with variable quantities of a more basic compound. This latter may very probably be a carbonate of chromium, which will be described further on.

As already mentioned, Lefort asserts that the precipitate, produced by the alkaline carbonates in solutions of the green modification of sesquioxyd of chromium, is hydrated oxyd, containing no carbonic acid. The following is the result of an analysis, made by myself, of such a precipitate. The chromium solution used was prepared by boiling the violet chrome-alum for about an hour, and cooling the solution before precipitation. The percentages obtained were 59·38 Cr_2O_3 and 40·62 CO_2. The carbonic acid is probably too high, and I regret that I did not have time to repeat the analysis. It is, however, sufficient to show that the substance contains carbonic acid, and that its composition is probably the same as that of the precipitate obtained in the violet modification.

The agreement of the results of Lefort, Wallace and Barratt, who all make the carbonate of chromium to be Cr_2O_3, CO_2 + 4HO, makes it probable that the bicarbonate, above described, loses its second atom of carbonic acid more readily than the other and is converted by washing and drying into a more stable monocarbonate. This latter is also formed, when a boiling solution of chrome alum is precipitated by carbonate of soda, as is shown by the following analysis of a precipitate thus prepared:

	Calculated.		Found.
Cr_2O_3	77·4	77·86	78·68
CO_2	22·	22·14	21·32
	99·4	100·00	100·00

3. *Carbonate of Alumina.*

Saussure* considers the precipitate, produced by alkaline carbonates in the solutions of alumina, to be a compound of alumina with a little alkaline carbonate. Muspratt† finds that the precipitate by carbonate of ammonia in alum is $3Al_2O_3$, $2CO_2$ + 16HO.

* Jour. Phys., lii, 290. † Chem. Soc., Qu. J., ii, 216.

Muspratt does not mention whether he tested the substance for ammonia, which it should contain, according to H. Rose,* who finds that the precipitate, after being washed, first with hot and then with cold water, has the composition, Al_2O_3, 3HO+NH_4O, $2CO_2$+HO. Langlois† finds the precipitate by alkaline carbonates in the salts of alumina to be $3(Al_2O_3, CO_2)+5(Al_2O_3, 8HO)$. Wallace‡ precipitates the chlorid by carbonate of soda, in very dilute solution, and dries the precipitate over sulphuric acid. He gives the formula, $3Al_2O_3$, $2CO_2$, 9HO. Bley§ obtains percentages of carbonic acid varying from 5·27 to 11·39, in the precipitate, produced by alkaline carbonates in solutions of alum, and considers it to be a mere mixture, of variable composition. Barratt‖ finds that the precipitate by carbonate of soda in chlorid of aluminum, after washing, drying, rubbing with water and again washing and drying over sulphuric acid, consists of alumina, free from carbonic acid.

The precipitates, which I have examined, were precipitated by carbonate of soda, in slight excess, from alumina-potash-alum, free from iron. The mode of analysis, used in the iron and chromium compounds, was not applicable in this case. The strongly alkaline wash-water, from the ignited alumina, contained alumina in large quantity, showing that aluminate of soda had been formed and carbonic acid, therefore, driven out of the carbonate of soda. Attempts to overcome this difficulty, by taking weighed quantities of alum and carbonate of soda, in equivalent proportions, and by exactly neutralizing the solution of alum by carbonate of soda, did not give good results. The method finally adopted was to wash the substance with water saturated with carbonic acid, until a portion of the filtrate, after being boiled to expel carbonic acid, gave no alkaline reaction. This would probably give correct results, since the water, being already saturated with carbonic acid, would hardly wash out any from the substance. The latter, moreover, would hardly absorb any more carbonic acid from the water, since, during the precipitation, free carbonic acid is given off in great quantity and the alumina must have combined with as much carbonic acid as it would be possible for it to take up. In other respects, the analyses were conducted like those of the carbonate of iron. The following are the results obtained:

	Prep. I.		Prep. II.	Prep. III.		Prep. IV.	
	1.	2.	1.	2.		1.	2.
Al_2O_3	79·13	79·32	75·95	81·37	81·91	77·51	76·72
CO_2	20·87	20·68	24·05	18·63	18·09	22·49	23·28
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

* Pogg. Ann., xcii, 452. † Ann. Chim. et Phys., [3] xlviii, 502.
‡ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70. § J. pr. Chem., xxxix, 1.
‖ Chem. News, i, 110, in J. pr. Chem., lxxxii, 61.

Preparation I. was analyzed in April: Preps. II. and III. in summer: Prep. IV. also in summer; but, to avoid a possible loss of carbonic acid in hot weather, it was precipitated from cooled solutions of alum and carbonate of soda, washed with ice-water saturated with carbonic acid, and pressed in a refrigerator. The variable composition of the substance led me to suppose that it was a mixture of more than one substance, and, for the same reasons as in the case of the carbonate of chromium, led me to make the following analyses of precipitates, produced by pouring alum into carbonate of soda, until the alkaline reaction became weak. Both were prepared in hot weather, but with the precautions above mentioned.

			Prep. I.		Prep. II.	
	Calculated.		1.	2.	1.	2.
Al_2O_3	51·4	70·03	70·44	71·06	77·79	77·02
CO_2	22·	29·97	29·56	28·94	22·21	22·98
	73·4	100·00	100·00	100·00	100·00	100·00

The composition of the first preparation comes pretty near the formula, while that of the second is very much like that of the substances, precipitated in the other way. Possibly in this last precipitate, the alum may have been poured in too rapidly, without agitation of the liquid, and thus caused, at the point where it fell, temporary excess of alum, thus affording the same probable cause for error as in the other mode of precipitation. The above results lead to this, I think, as the most probable conclusion: viz., that the normal carbonate of alumina possesses the composition Al_2O_3, CO_2, analogous to that of the carbonates of iron and glucina and one of the carbonates of chromium; and that the precipitate, produced by the alkaline carbonates in solutions of alumina, consists chiefly of this normal carbonate, generally mixed, however, with more or less of a more basic salt or of hydrate of alumina.

4. *Carbonate of Glucina.*

G_2O_3, CO_2.

Schaffgotsch* gives an analysis of a carbonate of glucina, precipitated by boiling a solution of glucina in carbonate of ammonia. He finds the percentages, 47·53 G_2O_3, 17·57 CO_2 and 34·90 HO, corresponding most nearly to the formula, $3G_2O_3$, $2CO_2+9HO$. Weeren† gives analyses of precipitates, obtained by boiling solutions of glucina in carbonate of ammonia, under somewhat different circumstances, and obtains the formulas, $4G_2O_3+4CO_2+11HO$: $3G_2O_3+2CO_2+10HO$: $7G_2O_3+3CO_2+14HO$. For a precipitate by carbonate of ammonia, not in excess, from a neutral solution of glucina in hydrochloric acid, he obtains the formula, $11G_2O_3+6CO_2+26HO$.

* Pogg. Ann., l, 63.

† Pogg. Ann., xc, 91.

The salt of glucina, which I used, was prepared by dissolving glucina in a slight excess of sulphuric acid and washing out the excess of acid with alcohol. The glucina used had been freed from alumina and iron, by dissolving it in sesquicarbonate of ammonia and precipitating it by boiling, and by again dissolving it in caustic soda and precipitating it by boiling. From the sulphate, thus obtained, the carbonate was precipitated by carbonate of soda, in slight excess, and analyzed in the same way as the carbonate of iron. The wash-water from the ignited glucina contained no glucina, no glucinate of soda having been formed. Analyses of two preparations gave the following results:

			Prep. I.		Prep. II.
	Calculated.		1.	2.	
G_2O_3	38·	63·34	63·31	63·57	63·52
CO_2	22·	36·66	36·69	36·43	36·48
	60	100·00	100·00	100·00	100·00

If glucina be regarded as a protoxyd, as it has been by some chemists, the above results would correspond to the formula, 3GO, CO_2 (calculated, G.=4·7, 63·40 GO and 36·60 CO_2).

5. *Carbonate of the sesquioxyd of Uranium.*

The precipitate, produced by carbonate of potash in nitrate of uranium, after being washed with cold water and dried in the air, has, according to Ebelmen,* the following composition: 3·66 KO, 3·87 CO_2, 81·98 U_2O_3 and 10·49 HO; and is probably a mere mixture.

The precipitates, which I have examined, were precipitated, some from the sulphate, others from the nitrate of uranium, by carbonate of soda, in as small excess as possible. The general mode of analysis, described under carbonate of iron, could not be employed here. There would be a variable mixture left in the bulbed tube, after ignition, consisting partly of uranate of soda (formed when sesquioxyd of uranium is ignited with carbonate of soda) and partly of proto-sesquioxyd of uranium. The substance was, therefore, ignited in a stream of dry hydrogen, free from carbonic acid, and the carbonic acid absorbed by a weighed soda-lime tube.† In this way, the sesquioxyd is

* N. Ann. Chim. Phys., v, 189.

† This method of absorbing carbonic acid by soda-lime, seems to work very well. In one case, a tube, used for the fourth time, still absorbed the carbonic acid perfectly, as was shown by a tube, containing pieces of solid caustic potash, attached to it, not increasing in weight. The originator of the method uses, instead of a chlorid of calcium tube, a U tube, containing pumice soaked in sulphuric acid, and having a little sulphuric acid at the bottom, to show the rate at which the gas is passing through. In my analyses, I used a chlorid of calcium tube, as usual, and to show the rapidity of the stream of gas, I employed a little bulb-apparatus, of the annexed form, passing through the cork at one end of the soda-lime tube, and filled with caustic potash. This has the advantage that it absorbs a large part of the carbonic acid and thus makes the soda lime last longer.

reduced to protoxyd, which does not drive out carbonic acid from carbonate of soda. The residue in the bulb was washed somewhat, ignited, evaporated to dryness with hydrochloric acid and chlorid of ammonium, and ignited in a stream of hydrogen. After thorough washing, it was again ignited in hydrogen and weighed as UO. This process is, according to Rose,* the best method for separating uranium from the alkalies.

The three following analyses were of precipitates from the nitrate. The first two were dried: the last was not.

			Prep. I.		Prep. II.
	Calculated.		1.	2.	
$3U_2O_3$	432	90·76	91·60	90·29	90·55
$2CO_2$	44	9·24	8·40	9·71	9·45
	476	100·00	100·00	100·00	100·00

The five next analyses were of precipitates from the sulphate. The last was precipitated by pouring the sulphate of uranium into the carbonate of soda: the others, as usual, by pouring the carbonate of soda into the uranium solution.

			Prep. I.		Prep. II.		Prep. III.
	Calculated.		1.	2.	1.	2.	
$3U_2O_3$.	432	95·16	95·52	94·60	94·13	94·68	94·54
CO_2.	22	4·84	4·48	5·40	5·87	5·32	5·46
	454	100·00	100·00	100·00	100·00	100·00	100·00

Notwithstanding the tolerably close agreement of the above results with the formulas just given, I am strongly inclined to think that these formulas do not express the true composition of the precipitates. A portion of one of the precipitates, after very protracted washing with cold water, still contained alkali, showing the presence of uranate of soda.† This result might indeed be inferred, almost with certainty, from the very strong affinity of sesquioxyd of uranium for the alkalies.‡ On account of this impurity, as well as the ease with which all these carbonates appear to lose carbonic acid, the observed percentage of carbonic acid should be less than the calculated. Instead of this, it is in nearly every case larger. I suspect, therefore, that the precipitates in question are mixtures of a less basic carbonate with uranate of soda. More of the latter appears to be formed in the precipitate from the sulphate of uranium than in that from the nitrate. Why this should be I cannot explain. What the true composition of the carbonate of uranium would be, if it could

* Analytical Chemistry, French ed., ii, 252.

† The carbonates of iron, chromium and alumina, after washing with cold water contained not a trace of soda. The carbonate of glucina contained a mere trace, which could probably have been removed by further washing.

‡ For example: the sesquioxyd of uranium cannot be separated from the alkalies by ammonia. Only the excess of alkali is separated. The rest is precipitated with the uranium, as uranate of the alkali. See Rose, Analt. Chem., Fr. ed., ii, 252.

be obtained pure, may be with probability inferred from the composition of its double salts with carbonate of potash and with carbonate of ammonia, in which it exists, according to Ebelmen,* as U_2O_3, CO_2. On the other hand, as the salts of the sesquioxyd of uranium, with the stronger acids, contain only one equivalent of acid, instead of three like those of the other sesquioxyds, analogy with the carbonates just described should make the carbonate of uranium contain less than one equivalent of acid to one of base. The first view is, however, I think, the more probable one.

Summary of the above results.

The following is a brief summary of the principal results arrived at in the foregoing pages:

1. All the carbonates in question, except, perhaps, the carbonate of uranium, lose carbonic acid readily, during the processes of washing and drying. To this may, in a great measure, be attributed the discordant results of previous observers.

2. The precipitate, produced by the alkaline carbonates in solutions of the persalts of iron, has the composition Fe_2O_3, CO_2.

3. The precipitate by the alkaline carbonates, in the violet salts of the sesquioxyd of chromium, varies somewhat in composition, but approaches the formula Cr_2O_3, $2CO_2$ and is probably a mixture of this with a little of the more basic salt next mentioned. The results of previous observers render it nearly certain that the above precipitate, by washing and drying, is converted into a more stable salt of the composition Cr_2O_3, CO_2. This latter is formed, when the precipitation takes place at the boiling point. The precipitate in the green solutions of chromium consists of carbonate, not of oxyd as stated by Lefort, and has probably the same composition as in the violet salts.

4. The precipitate by the fixed alkaline carbonates, in the salts of alumina, varies in composition, but approaches the formula Al_2O_3, CO_2 and is probably a mixture of this with a more basic salt. Both in this and in the case of the carbonate of chromium, the normal salt may be obtained nearly free from basic compounds, by pouring the alumina or chromium solution into that of the alkaline carbonate, instead of the reverse, so as to have always an excess of the alkali.

5. The precipitate by the alkaline carbonates, in the salts of glucina, has the composition G_2O_3, CO_2.

6. The precipitate by the alkaline carbonates, in solutions of the sesquioxyd of uranium, is undoubtedly a mixture of uranate of the alkali and carbonate of uranium. The latter, if it could be obtained pure, would very probably have the compo-

* Ann. Chim. et Phys., [3], v, 206–208.

sition U_2O_3, CO_2, in which state it exists, according to Ebelmen, in its double salts with the carbonates of potash and ammonia.

In conclusion, it will be observed that none of these carbonates conform to the theory of Berzelius, that the number of atoms of acid, in a neutral salt, corresponds to the number of atoms of oxygen in the base. On the contrary, their composition is generally the same as that of the salts of the protoxyds, one atom of acid to one of base.

Laboratory of the Lawrence Scientific School, Cambridge, July, 1862.

ART. XXIX.—*Supplements to the Enumeration of Plants of Dr. Parry's Collection in the Rocky Mountains,* (continued from p. 261.)

SUPPLEMENT I.—*Coniferæ*, by Drs. PARRY and ENGELMANN.

DR. PARRY collected too few specimens of the following Coniferæ for distribution, but as his notes are replete with interest they are given here (under marks of quotation) together with a few remarks of my own. G. E.

ABIES GRANDIS, Lindl. Not common in this region, resembling much the Eastern *A. balsamea*. Fendler's N. Mex. No. 828 is the same.

ABIES DOUGLASII, Lindl. "Abundant through the eastern mountain district, except on the higher elevations. A very sightly tree, of the average height of 80 feet, with a graceful oval outline; the spreading branches curving upwards at the extremities. Wood of slow growth, but very indifferent, inclined to warp and crack, turning reddish-brown in drying." This species, as well as the nearly allied *A. Canadensis*, is well distinguished from all our other Pines by the distinctly petioled leaves. Fendler's N. Mex. No. 829.

ABIES MENZIESII, Lindl. "A finely shaped tree, though of rather stiff outline, of rapid growth; wood very compact, but rather coarse grained and pitchy; the logs taper too rapidly to saw up to advantage." Cones pendulous from the end of the branches. Leaves stouter than in any other allied species, stiff and very acute, almost spinescent.

ABIES NIGRA, Poir. Probably the same as the northeastern tree (characterized by the slender and very acute leaves, ovate cones with thin and crenate margin of the scales), a pale-leaved form of which is usually named *A. alba*, but which Prof. Gray has demonstrated to belong to *A. nigra*. The true *A. alba* (leaves somewhat stouter and obtusish, cylindric cones with thickened entire margin of the scales) seems to extend from Canada to the northern Rocky Mountains, where it has been gathered by Bourgeau; but it has not fallen under Dr. Parry's or Dr. Hayden's observation, on the headwaters of the Kettle, Colorado, Missouri and Columbia Rivers, where *Abies nigra* seems to be abundant, extending down to Santa Fe (Fendler, N. Mex. No. 833). Dr. Parry found it

* Schw. xvii, 424, in Gmelin's Handb. Art. Cerium.

"composing almost the entire forest growth of the mountain slopes of Middle Park about the head of Grand River: a magnificent tree, 80 to 100 feet high, with an even, columnar trunk, below, 2–2½ feet in diameter, tapering upwards; of rapid growth; bark scaly, smooth and quite thin, of a purplish-brown color, full of tannin, and quite different from the rough brown bark of *A. nigra* of Wisconsin; wood remarkably white and soft, free of knots and scarcely resinous, preferred for inside work." Could this be *Abies rubra* Loud., and specifically distinct from *A. nigra*?

Pinus aristata, Engelm., in St. Louis Transact., vol. 2, tab. 5 and 6. Dr. Parry had the good luck to discover this very peculiar and exclusively alpine species "which does not descend lower than 9000 or 10,000 feet," on the higher mountains of Clear Creek. As a full description and a figure has been given in the Transactions of the St. Louis Academy, I confine myself here to the statement that it is our only representative of Endlicher's section, *Pseudostrobus*, which comprises numerous Mexican, a few Central American, and a single West Indian species; it is characterized by quinate entire leaves and horizontal ovate cones, with thin apophyses on the long-mucronate or aristate scales, and small winged seeds. In sheltered situations it forms a tree 40 or 50 feet high and 1 or 2 feet in diameter, but on the higher bleak mountains it is a stunted bush, often thickly covered with fruit. Its growth, at least in the latter localities, is exceedingly slow, as a stick of scarcely more than one inch in diameter, brought back by Dr. Parry, shows nearly fifty annual rings, some of them $\frac{1}{10}$ of a line, and none more than $\frac{1}{4}$ of a line wide.

Pinus flexilis, James. This species, discovered in the same regions by Dr. James, has to some extent remained doubtful, as his description in the account of Long's Expedition, and Torrey's diagnosis in the Annals of the New York Lyceum (vol. ii, p. 249) are based on notes only, no specimens having been collected. By later writers it has been ignored, until Mr. Fendler in 1847 collected it on the mountains above Santa Fe, (Coll. N. Mex. No. 832), when a short notice was published by the writer in the appendix to Wislizenus' Memoir of a Tour to New Mexico, etc., 1848. Endlicher, in his Synopsis Coniferarum, 1847, does not enumerate it, and Carrière in his Traité des Conifères, 1855, credits it to Wislizenus, translating only my short remarks. Nuttall, however, had already (in 1849) given a somewhat extended account of it, with a poor figure, in the continuation of Michaux's Sylva (vol. iii, p. 107, pl. 112), without clearing up the doubts, which Dr. Parry in his present expedition, 1862, is expected finally to settle. My brother, H. Engelmann, collected it on the head waters of the Platte, and Dr. Hayden on the mountains about the head waters of the Yellowstone, Missouri and Columbia rivers. Dr. Parry notes that the cones grow several together, "semipendulous" at the extremity of the horizontal branchlets; while James gave his plant "erect" cones. Near Santa Fe it grows at the elevation of 8000 or 10,000 feet, and in favorable situations becomes 60 or 80 feet high and bears "pendulous" cones, according to Fendler's note. *Pinus flexilis* is certainly intermediate between the sections *Cembra* and *Strobus* of Endlicher, and unites the two, as does *P. cembroides*, Newberry, Pacif.

R. Rep., vol. vi, Bot., p. 44, not Zucc.,* if, indeed, this is not a mere form of *P. flexilis*, approaching by its short cones close to *P. Cembra*. The large seeds of *P. flexilis* are, as Dr. James already stated and as Dr. Hayden confirmed, eaten by the Indians. They are distinguished from those of any other of our Pines by a persistent, sharp, keeled margin, representing the wing.

PINUS PONDEROSA, Dougl., is "common through all the lower valleys and less elevated districts of the mountains, associated with *A. Douglasii* and *A. Menziesii*; a most valuable timber tree." Fendler's N. Mex. No. 831. Male aments cylindrical, several inches long.

PINUS CONTORTA, Dougl., "is quite abundant on the crest and slopes of dry subalpine ridges, forming the principal part of the forest there, and extending to near the snow line; a symmetrical tree of rapid growth, 30 or 40 feet high, with slim and tapering trunk a foot in diameter, a smoothish, grayish-brown bark, detached in thin scales, and tough but coarse wood, which is liable to warp, and rarely cut into boards."

SUPPLEMENT II.—Revision of the *Œnotheræ* of the subsection *Onagra*; by Dr. ENGELMANN.

[*Prefatory Note*, by A. GRAY.—Nuttall, in his Genera, stated that Pursh had confounded two species under *Œ. albicaulis*, viz., his own *Œ. albicaulis* and *Œ. pinnatifida*. In *Plantæ Wrightianæ* I had come to the conclusion that Pursh was right, not then knowing the seeds of *Œ. pinnatifida*, Nutt. Consequently, when good fruit of the latter came to hand, in Wright's second collection, in Pl. Wright, 2, p. 56, I carelessly referred the specimens to *Œ. coronopifolia*, on account of their seeds, notwithstanding their longer capsules, overlooking the other characters, and wrongly supposing that Nuttall's description of the seeds of his *Œ. pinnatifida* or *Bradburiana* somehow belonged to *Œ. coronopifolia*, which, as I had shown in Pl. Fendlerianæ, has such seeds, while those of *Œ. albicaulis* are longer and smooth. Dr. Engelmann has recently corrected this oversight, and in the following memorandum has established the three species upon a good foundation. I greatly doubt the distinctions based upon the duration of the root, although *Œ. albicaulis* and *Œ. coronopifolia* generally, if not always, have the appearance of being perennial, while

* Zuccarini's plant of that name is one of the curious little group of American Nut-pines, including the following four species: *Pinus monophyllos*, Torrey and Fremont, with single (not connate, as Endlicher would have it) leaves; *P. edulis*, Engelm., with 2 leaves; *P. cembroides*, Zucc., (including *P. Llaveana*, Schiede, not Torr., and *P. osteosperma*, Engelm.) with 3 leaves; and *P. Parryana*, Engelm. (*P. Llaveana*, Torr. Bot. Mex. Bound., p. 208, t. 53) with 3-5, mostly 4 leaves. Other characters, taken principally from the bracts of the young shoots, strengthen the specific distinctions. This very natural little group is characterized by the small, almost globose cones, the scales bearing large pyramidal apophyses and large edible seeds, the wings of which remain attached to the scale, which, I suspect, is the case in all "wingless" seeds of pines; in *P. Pinea*, however, the wing is very distinct and detaches itself clearly from the scale and at the same time also from the seed itself, which is likewise the case in the closely allied, though 5-leaved, Californian *P. Torreyana*, Parry, where the wing, besides, is very thick, and of a corky substance. The great variability in the number of leaves in the nut-pines proves that sectional characters taken from them are without value.

Œ. pinnatifida flowers early from a slender monocarpic root; I should not rely much upon the shape and size of the petals; and the leaves are most polymorphous. But, in brief,

Œ. CORONOPIFOLIA, Torr. and Gray, is well marked by the strong villosity of the throat of the calyx, the short and thick, ovoid-oblong, or at most linear-oblong capsules, and the large, oval or oblong, strongly costate seeds, the ribs tuberculate.

The two following both have the calyx glabrous (rarely with a few hairs) in the throat, much larger petals, and larger pods.

Œ. PINNATIFIDA, Nutt., has less elongated and stouter capsules, and small, ovoid, striate-reticulated seeds (with pits between the ribs), apiculate at the hilum.

Œ. ALBICAULIS, Nutt., in all its forms, has elongated-oblong and perfectly smooth seeds, and its longer, linear, capsules are closely sessile by a broad base, and mostly porrected or divaricate from the axis which bears them, often flexuose.

Dr. Parry's No. 116 is *Œ. pinnatifida;* his 117, probably a canescent form of *Œ. albicaulis;* neither are in fruit.

The following communication from Dr. Engelmann was received too late for insertion in its proper place in the July No. of the Journal. A. G.]

"A large suite of specimens enables me to clear up some difficulties which have environed the following species of *Œnothera.*

"1. ŒNOTHERA CORONOPIFOLIA, Torr. & Gr. Fl. 1, p. 245; Gray, Pl. Fendl., p. 43. Perennis, saepe multicaulis, humilis, erecta seu erecto-patula, puberulo-canescens, strigosa seu hispida; foliis infimis lineari-spathulatis, caeteris pectinato-pinnatifidis; *tubo calycis ad faucem dense villoso; petalis suborbiculatis integris* stamina aequantibus pistillo brevioribus; capsula ovato-seu lineari-oblonga *torulosa basi nunc in pedicellem brevissimum attenuata suberecta; seminibus magnis ovatis turgidis subobtusis varie oblique truncatis tuberculatis.* My specimens were collected by Mr. Fendler (No. 222) near Santa Fe, along waterducts, and by Dr. Hayden on the sandhills of the Loupfork, on "Running Water." Stems ½–1 foot high: flower white, turning deep red, about an inch in diameter: capsule in Fendler's specimens about an inch long, in Hayden's only about 4 lines long, thicker than in the allied species: seeds yellowish-brown, about a line long, thick, beset with tubercles arranged in longitudinal rows.

"2. ŒNOTHERA PINNATIFIDA, Nutt., Gen. 1, p. 245; Torr. & Gr. Fl. 1, p. 494. *Œ. albicaulis*, Pursh, Fl. 2, p. 733: DC. Prodr. 3, p. 51, non Nutt. *Œ. Purshii*, Don. Syst. 2, p. 688. *Œ. Purshiana*, Steud. Nom. 2, p. 207: Annua seu biennis, humilis, diffusa, (rarissime erecta), puberula, rarius sursum hirsuta; foliis imis obovato-spatulatis acutis seu obtusis integris, caeteris pinnatifidis saepe ciliatis; *tubo calycis ad faucem nudo; petalis late obcordatis seu profunde emarginatis genitalia superantibus;* capsula lanceolato-lineari *torulosa sessili suberecta; seminibus ovatis turgidis utrumque apiculatis foveolatis seriatim inter costas dispositis elegantes notatis.* Sandy soil on White River, Upper Missouri, Nuttall, Geyer in Nicollet's Expedition, Dr. Hayden; Las Vegas and Santa Fe, New Mexico, Dr. Wislizenus, Mr. Fendler; the latter's specimens, few in number, bearing his private number 239, were distributed with others of the next species under No. 223; Southern New Mexico, Wright (referred to *Œ.*

coronopifolia in Pl. Wright, 1, p. 69.) All the specimens I have seen are either annual (sometimes simple and one-flowered) or, usually, biennial, with rosulate entire radical leaves; branching from the base, diffuse or even decumbent; an erect form was collected by A. Gordon on the Upper Canadian River, No. 29, similar to the last species in habit. Stems usually 4–6 inches high, but, according to Nuttall, the decumbent branches sometimes 2 feet long. Flowers 2½–3 inches in diameter, white, turning pale red: capsule 1–1¾ inches long: seeds very regularly and prettily pitted between the longitudinal ribs, 0·6–0·7 of a line long, yellow. Don and Steudel have changed Nuttall's earlier name, but his must stand and Humboldt's plant, described five years later under the same name, may receive the name of *Œ. Humboldtii.*

"3. Œnothera albicaulis, Nuttall in Fras. Cat., 1813, & Gen. 1, p. 245; Torr. & Gr. Fl. 1, 495; Gray Pl. Wright 1, p. 69, & 2, p. 56: Perennis, glabra, puberula seu hirsuta; caulis *cortice albida membranaceo nitente;* foliis maxime variis; *petalis orbiculato-ovatis* in unguem plus minus attenuatis *integris* stamina superantibus pistillum aequantibus; *sapsula e basi crassiore sessili lineari divaricata saepe flexuosa seu deflexa; ceminibus minoribus lineari-lanceolatis laevibus.* A common plant on the western plains, extending into Oregon, New Mexico and Chihuahua, as variable in habit, growth and foliage as it is common, but always easily recognized by the unvarying characters of the flower and fruit as above indicated, and also by its white glistening stems and branches, the epidermis of which is apt to peal off in the manner of many Loasaceæ. The white flowers, 1½–1¾ inches in diameter, at last turn pale-red; the very slender capsule, connected by a very thick base with the stem, is usually 1½–1¾ inches long, and spreads at right angles, or is curved or twisted in various directions. Seeds smooth, dark-brown, lance-linear and usually very acute at one end, and 0·8 line long; var. δ, has smaller (0·6 line) and obtuse seeds. According to foliage and pubescence I arrange the specimens before me under the following varieties:

α. Foliis basi in petiolum brevem attenuatis.

Var. α. Nuttallii: erecta, glabriuscula seu puberula, simplex seu ramosa; foliis linearibus seu lanceolatis seu oblongis integris vel plus minus dentatis. Here belongs *Œ. pallida*, Dougl., with its variety *leptophylla*, Torr. & Gr., as already indicated by Prof. Gray. Nuttall describes this form as sometimes 3 feet high, and Geyer notes that in the sandy plains of Devil's Lake and at the sources of St. Peter's River it forms shrubby bushes of the size of Spartium scoparium, growing even 4 feet high; but it seems more usually between one and two feet high. Leaves 1–2½ inches long and 1–6 lines wide. One of the broadest leaved forms is Fendler's N. Mex. No. 224.

Var. β. runcinata: branchiato-ramosa, patula, glabra, puberula seu canescens; foliis lanceolatis grosse seu sinuato-dentatis. This is *Œ. pinnatifida*, Gray Pl. Fendl., p. 43 (description and most of the specimens No. 223, all those with the private number 243). Fendler gathered it near Santa Fe; Fremont in his 3d Expedition collected a glabrous (No. 222) and a very canescent (No. 178) form, the latter with singularly short but apparently fertile capsules, scarcely 3 lines long.

b. Foliis basi lata truncata sessilibus.

Var. γ. BREVIFOLIA: tota glaberrima, erecta, ramosissima; foliis late ovatis abbreviatis grosse dentatis. Sandhills south of El Paso, Dr. Wislizenus, No. 99. Leaves dark green, while all the other forms are pale or grayish, 4–6 lines long, acutish, or often rounded at the end.

Var. δ. TRICHOCALYX: erecta, parce ramosa, canescenti-hirsuta; foliis lanceolatis seu lanceolato-oblongis sinuato-dentatis. Las Vegas, New Mexico, Dr. Wislizenus, No. 473.—This is no doubt Nuttall's *Œ. trichocalyx*, Torr. & Gr. Fl. l. c., the specific identity of which with *Œ. albicaulis* Prof. Gray has already indicated. The long hair on the stem, ovary, and especially the calyx, consists of a single cell, remarkably broad at base, tapering to an acute point;—it is however the form of hair I find in all long-haired *Œnotheræ*. G. E.

SUPPLEMENT III.—Revision of the genus *Castilleia*; by A. GRAY.

CASTILLEIA, Linn. f.

The species of this genus are most troublesome and unsatisfactory, not only on account of the difficulty of investigating the dried specimens, but also from the variability of the characters which have been relied upon in arranging them, and especially of the calyx. Although the latter affords good characters on the whole, yet the degree of fission and the form of the lobes are far from being constant in several species; and the same remark applies in a measure to the relative length of the galea and of the lower lip. The structure of the lower lip is likely to afford some good characters; but they are not readily nor very safely to be derived from dried specimens. Bentham's four sections (in De Candolle's Prodromus) do not prove to be as distinct as they would seem. The second and the third were better combined into one, which will include all our North American species but two. The fourth section is pretty well marked, but not absolutely. Of the first, which would appear to be quite distinct, I have no specimens. Beginning with Bentham's fourth section, since this comprises the original species :—

§ 1. HEMICHROMA or EUCASTILLEIA. Calyx (sæpe incurvus) antice profunde fissus, postice leviter bifidus sæpius 4-dentatus.

C. LINARIÆFOLIA, Benth., is one of the best characterized and the most northern species. It is known by its long, narrow and glabrous cauline leaves which are not dilated at the base, the floral ones scarlet-colored, by the subulate teeth of the calyx, and by the long and narrow galea, which is more slender and falcate than in *C. tenuiflora;* the lobes of the lower lip linear-subulate. But the flowers are not always sessile, nor the leaves only one-nerved and entire; these are often 3-cleft or 3-parted, and more or less distinctly 3-nerved at the base. To this species clearly belongs *C. fulgens*, Nutt. in herb. Philad., and *C. candens*, Durand in Pacif. R. R. Rep. 5, p. 12. (But No. 70 of the Californian (Fort Tejon) collection of Xantus, also specimens collected by Dr. Newberry in the Colorado expedition, which I had mistaken for *C. candens*, belong to *C. affinis*). This is No. 583 of Fendler's New Mexican collection, and 246 of Dr. Parry's Rocky Mountain collection.

C. TENUIFLORA, Benth., Pl. Hartw. No. 191, as Bentham intimates, should probably include *C. longiflora*, Kunze, and *C. canescens*, Benth., (which is Gregg's No. 434, 610, and Coulter's No. 1354), all from Mexico.

C. ORIZABÆ I have not seen, unless Coulter's No. 1352 and 1353 belong to it.

C. FISSIFOLIA, Linn. f. (No. 835, coll. Venezuel. Fendler). To this Weddell refers all the five other South American species of this section, including even *C. integrifolia*, Linn. f.

C. LAXA, Gray in Bot. Mex. Bound., p. 119, of Arizona (coll. C. Wright, No. 1490), has a broader calyx and corolla than any of its allies, the former very thin-membranaceous, colored, and with obtuse teeth, the galea slightly falcate; the leaves thin and not dilated at the insertion.

§ 2. EUCHROMA (incl. *Callichroma*). Calyx antice et postice fissus, segmentis integris emarginatis vel bifidis.

I have nothing to say of the six Mexican and South American species in the Prodromus. The proper North American ones I understand as follows:

* *Radice annua vel bienni.*

+ *Integrifoliæ.*

C. AFFINIS, Hook. & Arn. Folia lineari seu lanceolato-attenuata, floralia raro trifida: flores pl. m. pedicellati: calyx usque ad medium bifidus, segmentis angustis saepius bifidis vel emarginatis: galea elongata falcata; labium brevissimum.—The calyx is generally cylindrical, more or less curved, and reddish, and the wholly exserted galea 6 to 8 lines long: but the species, I believe, passes by regular gradations into the

Var. MINOR, Gray in Bot. Mex. Bound., p. 119 (*Euchroma simplex* and *E. lanceolata*, Nutt. in herb. Acad. Philad.), which has smaller flowers, less colored floral leaves, a green and herbaceous calyx, the galea of the pale corolla only three or four lines long. Hartweg's No. 1877 is a good intermediate form. The calyx in both forms (as I have elsewhere noted) varies with its segments deeply bifid, moderately bidentate, or entire.

C. INDIVISA, Engelm. Folia caulina lineari-lanceolata, floralia obovato-dilatata rarius sublobata: flores sessiles: calycis segmenta lata sæpius emarginata; galea brevis breviter exserta. I have not the means of collating this with *C. lithospermoides*.

+ + *Laciniatifoliæ.*

C. COCCINEA, Spreng. The only annual, or perhaps biennial, species with laciniately cleft leaves; confined to North America east of the Rocky Mountains, and mostly east of the great plains, ranging from Rupert's Land to Texas.

* * *Radice perenni.*

+ *Foliis floralibus superne pl. m. dilatatis et coloratis.*

++ *Villoso-pubentes, vel inferne glabræ, pube versus apicem caulis, etc., patente pilosa vel hirsuta sæpius viscosa.*

C. PARVIFLORA, Bongard. Fere undique piloso-pubescens vel hirsuta, vix hispida: folia pleraque trifida vel pinnato-laciniata, floralibus apice sæpissime rubro-colorata: calycis segmenta aut emarginato-biloba, aut profunde bifida lobis oblongis seu linearibus: corollæ labium brevissimum.

—This is apparently the commonest species and of widest range west of the Rocky Mountains, extending from Russian America to Southern California. The name given by Bongard is much the earliest, but not a good one, being founded upon what, I believe, is only a northern form of Bentham's *C. hispida* (a later and scarcely more appropriate name), with a less developed corolla. The length of the galea appears to be subject to variation in this species, as in *C. pallida*, and the calyx-segments still more so. To the present species may be referred: *C. coccinea*, Lindl. Bot. Reg. t. 1136 (non Spreng.), which, as its calyx-segments are described as being dilated and retuse, Mr. Bentham should rather have referred to his *C. Douglasii*. *Euchroma angustifolia* and *E. Bradburii*, Nutt.! in Jour. Acad. Philad. 7, p. 44, 47 (1834), both hirsute forms with deeply cleft and narrow calyx-segments. *Castilleia hispida*, Benth. in Hook. Fl. Bor. Am. & in DC. Prodr., 10, p. 532. *C. Douglasii*, Benth. in DC. l. c. p. 530; the commoner form, with oblong or more dilated and slightly lobed or cleft calyx-segments. *C. desertorum*, Geyer in Hook. Kew Jour. Bot. 5, p. 258, which is just Nuttall's *E. angustifolia*, but with partly yellow bracts. *E. macrocalyx*, *E. villosa*, *E. laciniata*, and *E. viscosa*, Nutt. in herb. Acad. Philad.

C. PALLIDA, Kunth. Inferne sæpius glabra vel glabrata, caule versus apicem calycibusque villosis: folia inferiora sæpissime integra (e forma lineari ad ovato-lanceolatam), floralia vulgo pl. m. incisa vel laciniata et albido-colorata: calycis segmenta bifida seu biloba: galea aut breviuscula aut elongata.—The most northern species, and extending round the world on the borders of the arctic zone. I am well satisfied (especially from White Mountain specimens, clearly all of one species) that the galea varies much in length or degree of development,—the lower lip remaining nearly uniform,—and that, accordingly, *C. Sibirica* and *C. septentrionalis* of Lindley are states of one species, *C. pallida*,—to which belong *C. acuminata*, Spreng. (*Bartsia acuminata*, Pursh), *C. occidentalis*, Torr. (a dwarf alpine form), *Euchroma lutescens*, Nutt. in herb. Acad. Philad., and, as a variety:—

Var. MINIATA: viridior, inferne glabra; foliis floralibus pl. m. miniatis; galea elongata magis exserta. *C. miniata*, Dougl., Benth. *Euchroma integrifolia*, Nutt. in herb. Hook. & Acad. Philad. This is pretty well marked on the whole; but in Rocky Mountain specimens it runs both into *pallida* and *septentrionalis*. As to "*C. pallida* var. *Unalaschensis*, Cham. and Schlecht.," from Sitcha, my specimens from Bongard consist of narrow-leaved ones with a short galea (true *C. pallida*) and a broader-leaved one with elongated galea, good *C. septentrionalis*, apparently, referred by Bentham to *C. miniata*. C. No. 1, Bourgeau's coll. in Palliser's Exped., is *C. miniata* with the upper cauline and floral leaves unusually cleft.

C. LATIFOLIA, Hook. & Arn. Undique viscoso-hirsuta, laxe ramosa: folia brevia, obovata, obtusissima, plerisque integra, floralia apice dilatata, 3–5-lobata, rubro-colorata: calycis segmenta lata emarginato-biloba: corolla parva. A well-marked Californian species. The comparatively short and broad calyx is sometimes equally cleft before and behind, sometimes much deeper posteriorly.

++++ *Tomentosæ, vel pube caulis molli implexa. Folia caulina linearia integra, vel trifida.*

a. Incanæ ; calycis segmentis dilatatis subintegris.

C. FOLIOLOSA, Hook. & Arn. Floccoso-tomentosa, tomento e pilis ramosissimis ! Caules suffruticosi cum foliis adultis quandoque glabrescentes : galea ultra segmenta calycis spathulato-oblonga sæpius retusa leviter exserta.—The peculiarity of the pubescence is indicated in Bot. Mex. Bound. Survey, p. 118.

C. LANATA, Gray in Bot. Mex. Bound., l. c. Herbacea, tomento arachnoideo appresso albo-lanata : flores fere *C. foliosæ*, sed majores.

b. Cinereo-puberulæ vel subtomentosæ ; calycis segmentis sæpissime bifidis ; galea exserta. Folia supra nunc glabra.

C. INTEGRA, Gray in Bot. Mex. Bound. l. c. Caulis laxe tomentosus : folia (sæpius tomentulosa) omnia integerrima, vel floralia sublobata, raro trifida : flores sesquipollicares, galea majore et labio breviore quam *C. purpureæ*.—Besides the numbers already cited, this is No. 244 of Parry's Rocky Mountain collection (a dwarf or subalpine form) ; and my *C. tomentosa*, from Mabibi, Arizona, Thurber, appears to be a more tomentose state of the same species, the flowers in the specimen not well developed. It is closely related to *C. purpurea*, and perhaps runs into it. To that, at least, I now refer the undistributed specimens of Wright's first collection.

C. PURPUREA, Don. Caulis tomentulosus vel cinereus : folia pubera vel glabrata, superiora vulgo cum floralibus trifida seu laciniata : flores pollicares, labio minus quam in affinibus abbreviato (2–2½ lin. longo). Floral leaves varying from cherry-red to flesh-color, or light yellow. Lower lip of the corolla by no means half the length of the galea in well developed flowers. To this species belongs *C. angustifolia*, Gray in Bot. Mex. Bound. l. c., excluding the synonymy, and excluding the plant of H. Engelmann from Bridger's Pass, the latter being *C. miniata*. It is, accordingly, Wright's No. 1491 and 1492, and Lindheimer's 488 and 669.

** *Foliis (plerisque 3–5-fidis lobis linearibus) floralibus apice nec dilatatis nec coloratis. Calyx aut æqualiter aut antice profundius fissus, segmentis alte bifidis. Corollæ labium magis quam in cæteris trisaccato-carinatum, lobis galeæ dimidium adæquantibus. Plantæ humiles, subvillosæ vel subcinereæ.*

C. SESSILIFLORA, Pursh. Calyx et corolla tubo elongato angusto ; labio tripartito, lobis lineari-lanceolatis. Corolla evoluta bipollicaris, galea 4–6 lin. longa.

C. BREVIFLORA, Gray, Pl. Parry, No. 243. (*Euchroma breviflora*, Nutt. in herb. Philad.) Spithamæa, spica densa, florescente vix pollicari ; calyce ovoideo-oblongo, lobis lanceolatis ; corollæ luteæ tubo fere incluso, labio inferiore triplicato-saccato breviter trifido, lobis oblongis obtusis.—Rocky Mountains, Nuttall, Parry, No. 243. A well-marked species of this genus ; the lip of the corolla about as long in proportion to the galea as in *C. sessiliflora*, but more trisaccate,—therefore one of the transitions to *Orthocarpus*. The calyx in flowers of the same spike is sometimes about equally cleft behind and before, and sometimes split in front while the posterior cleft is no deeper than that between the lateral lobes.

Excludendæ. Small indeed are the absolute distinctions between some of the third section of *Orthocarpus* and *Castilleia*.

Euchroma albida, Nutt. in herb. Acad. Philad., is *Orthocarpus attenuatus*, Gray in Bot. Whippl. Exped. Pacif. R. R. Rep. 4, p. 121. This is the "O. No. 1," of Dr. Lyall's collection on the Oregon Boundary, from Lopez Island, distributed at Kew Gardens.

Euchroma pallescens, Nutt. in herb. Acad. Philad., from the Rocky Mountains, being a near relative of the preceding and of *Orthocarpus densiflorus*, and I believe not a described species, would take the name of *O. pallescens*. The lobes of the lower lip of the corolla are so conspicuous that it can hardly be *O. hispidus*, Benth., a species unknown to me. The segments of the deeply two-cleft calyx are merely bifid at their apex. Near to this, if not the same, but more hairy, with deeper-cleft calyx-segments, and yellowish corolla almost an inch long, are specimens of Geyer's Rocky Mountain collection, distributed as No. 291, therefore probably those mentioned in Hook. Kew Jour. Bot. 5, p. 259. Here also the lobes of the lower lip are quite conspicuous, and the incompletely developed specimens might very readily be taken for those of a *Castilleia*.

SUPPLEMENT IV.—Review of the genus *Mertensia*; by A. GRAY.

MERTENSIA, Roth.

The species of *Mertensia* which I have been able to examine, although not a little perplexing, may perhaps be best discriminated as follows:—

§ 1. Filamenta gracilia antheris multo longiora: corollæ tubo calyce alte 5-fido pluries longiore, limbo levissime lobato, plicis faucialibus nullis. Tota glaberrima.

1. M. VIRGINICA, DC.—The disk is annular, but on each side developed into a large lobe or glandular appendage. That of *M. Fendleri* and of some specimens of *M. paniculata* approaches it. Corolla villous inside just above the obscurely 10-glandular base of the tube.

§ 2. Filamenta antheris plus minus angustiora et longiora: corollæ limbo lobato.

2. M. MARITIMA, Don. Corollæ tubo limbo breviore calycem sub-5-partitum subæquante, plicis conspicuis.

3. M. PALLASSII, Don. *M. Sibirica*, DC., &c. *Pulmonaria Sibirica*, Pall., non Linn. *Lithospermum Pallassi*, Ledeb. Corollæ tubo limbo 1½–2-plo calyce 3-plo longiore, plicis tenuibus. Siberia.

§ 3. Filamenta magis dilatata, antheris æquilata seu latiora et plus minus breviora: corollæ limbo 5-fido.

* *Calyx haud ultra medium 5-fidus.*

4. M. FENDLERI (sp. nov.): foliis subtus cauleque lævibus supra cum pedicellis appresse hispidulis, caulinis oblongo-lanceolatis; racemis pauciforis; corollæ tubo lobis calycis hirsuti lato-lanceolatis limboque vix longiore intus supra basim annulato-villoso. New Mexico: foot of hills on Santa Fe Creek, Fendler No. 625. Discus pl. m. bilobus.

* * *Calyx 5-partitus, in M. oblongifolia et M. alpina quandoque alte 5-fidus.*

+– *Corolla tubo quam limbus (i. e. pars dilatata supra faucem) 2–3-plo longiore.*

5. M. DAVURICA, Don. Gracilis; foliis caulinis linearibus supra cum calyce subincano-hirtis; corolla ima basi annulato-pilosa, cæt. glabra. Siberia. The hairy ring (much less conspicuous than that of the foregoing species) is here at the very base of the corolla, occupying the position in which ten obscure glands or slight thickened spots are generally discernable: these are most evident in the following species, and in *M. alpina*.

6. M. OBLONGIFOLIA, DC., Hook. Kew Jour. Bot. 3, p. 295. *Pulmonaria oblongifolia*, Nutt.! *Lithospermum marginatum*, Lehm. in Hook. Fl. Bor. Am. Humilis; foliis caulinis oblongis vel spathulato-lanceolatis plerumque obtusis; segmentis calycis lanceolatis seu linearibus acutis corollæ tubo intus glaberrimo 2–3-plo brevioribus. Interior of Oregon, Utah, &c. Varies with the sepals very narrow and ciliate with long and rigid bristles, as in Nuttall's original specimens collected by Wyeth; or with these ciliæ minute or sparse or obsolete, as in most specimens; in Geyer's No. 316, the calyx is hardly 5-parted, and its segments broader; in Spalding's, from Clear Water, the leaves are unusually broad. The leaves resemble those of Heliotropium Curassavicum.

+– +– *Corolla tubo quam limbus ad summum sesquilongiore.*

++ *Elatæ, 1–3-pedales: folia caulina ovata seu ovato-lanceolata, acutissime acuminata vel acutata, costato-venosa; corollæ semipollicares seu paullo longiores.*

7. M. PANICULATA, Don. *M. paniculata, pilosa, pubescens, lanceolata? stylosa? & Kamtschatica?* DC. Hirsuta, hirtula, vel glabrata; segmentis calycis lanceolatis seu lanceolato-linearibus acutis hirsutis vel hispido-ciliatis tubo corollæ intus sparsim piloso paullo vel dimidio brevioribus.—A specimen of *L. denticulatum*, Hook. & Arn. from Kotzebue's Sound in Beechey's Voyage, p. 128, in herb. Torr., is certainly of this species, which probably occurs in Northeastern Asia also. H. Engelmann's specimens from Medicine-Bow Mountains and Dr. Parry's No. 286 are glabrate and dwarf mountain forms of *M. paniculata*, with barely acute leaves, and are Pursh's *Pulmonaria lanceolata*. Nuttall's *P. marginata* is much the same.

8. M. SIBIRICA, Don, non DC. *M. denticulata* (Don.) *& ciliata*, DC. (*Pulm. Sibirica*, Linn.) Glaucescens, subpubescens, vel glabra; segmentis calycis oblongis seu oblongo-linearibus obtusis ciliolatis tubo corollæ intus sparsim piloso vel fere glabro 2–4-plo brevioribus. Rocky Mountains, Eastern Siberia.

++ ++ *Pumila: folia caulina obtusa vel acutiuscula, vix venosa: corollæ ¼–⅓-pollicares.*

9. M. ALPINA, Don. *M. Drummondii*, Don. *Pulmonaria alpina*, Torr. *Lithospermum Drummondii*, Lehm., in Hook. Fl. Bor.-Am. Spithamæa ad subpedalem; foliis spathulato-oblongis lanceolatis vel supremis oblongo-ovatis parvulis; segmentis calycis nunc ovato seu oblongo-lanceolatis obtusiusculis nunc lineari-lanceolatis acutis ciliatis corollæ tubo limbum

adæquante paullo brevioribus.—Either glabrous or hirsute. Richardson's plant from the arctic coast is a large-flowered form of Torrey's *P. alpina*. Parry has an alpine form (No. 287), and a loose, evolute form with longer and narrower leaves (No. 284); in these the tube of the corolla is usually pilose inside near the middle; but it is not so in Torrey's original specimens of *M. alpina*, nor in Hooker's *M. Drummondii*. In the latter, and in Parry's specimens, as in all of the various other species I have examined, the stamens are inserted in the throat of the corolla. In the flowers of Dr. James' specimens, they are inserted pretty low down on the tube, so that the tips of the anthers barely reach to the level of the faucial plicæ or appendages. This is the case in all the various specimens I have examined (of Burke, Fremont, and Stansbury) from the western side of the Rocky Mountains, of what seems to be a narrow-leaved and hirsute variety of this species. Contrary, however, to the dimorphism in other *Borragineæ*, *Rubiaceæ*, &c., the included stamens are here accompanied by a *short* style.

§ 4. Filamenta antheris sublongiora et equilata: corollæ limbo lobato: achenia echinata!

10. M. RIVULARIS, DC. *M. elliptica*, Ledeb. ex Regel & Tiling, Fl. Ajan. N.E. Siberia and Kamtschatka. Corolla with the tube hairy within towards the base: plicæ at the throat conspicuous. I have only a specimen from Tiling's Ajan collection. In this the fruit is conspicuously *echinate* with soft prickles,—a remarkable peculiarity, which is not noticed in Regel's account of this collection.

*** Dr. Hooker, in his Arctic Essay, received long since the above was written, adopting Sir William's suggestion, refers the high arctic *M. Drummondii* (*Lithospermum Drummondii*) to our *M. Virginica*. Although Lehmann describes the corolla "*fauce notata protuberantiis quinque*, I found no appendages in an original specimen in herb. Torrey, just as Dr. Hooker notes. But I also found them obsolete in specimens of *M. alpina* and of other species in which they are sometimes evident. Wherefore I rejected the character from the diagnosis of Section 3.

ART. XXX.—*Researches on the Platinum Metals;* by WOLCOTT GIBBS, M.D.

(Continued from vol. xxxi, p. 71, Jan., 1861.)

§ 3.

THE mass of soluble chlorids obtained by the above method contains all the platinum metals, although only traces of osmium and palladium are present; in addition there is usually more or less insoluble matter, consisting partly of the impurities of the ore itself and partly of undissolved oxyds. A certain portion of iron also remains with the mass even after careful washing.

The washings contain a very large quantity of iron, a little ruthenium in the form of bichlorid of ruthenium and potassium,

and possibly a trace of palladium. When the washing with chlorid of potassium has been carefully executed with a cold and saturated solution, the quantity of ruthenium dissolved is too small to be worth separating. It only remains therefore to separate the metals in the mass of mixed double chlorids. Platinum and iridium exist in this mass in the form of bichlorids, as $PtCl_2$,RCl and $IrCl_2$,KCl; ruthenium is present partly as sesquichlorid and partly as bichlorid, Ru_2Cl_3,2KCl and $RuCl_2$,KCl; rhodium appears to be present only as sesquichlorid, Rh_2Cl_3, 3KCl, so far at least as it is possible to determine. The separation of these metals from each other is a problem of no ordinary difficulty.

Of the methods which have been proposed for this purpose I have no hesitation in saying that that of Claus is the only one which yields the different metals in a state of purity. In fact after a long and laborious study of the subject I believe that no other chemist has worked with pure preparations of iridium and rhodium, the descriptions even of Berzelius applying only to mixtures of isomorphous salts in various proportions. In addition the discovery of ruthenium by Claus rendered a complete revision of the subject necessary. Such a revision Claus has himself given in his elaborate and most valuable memoir already cited.* For the details of Claus' processes I must refer to his paper. In principle his method consists in separating osmium and ruthenium by fusion with a mixture of caustic potash and saltpeter; cold water then dissolves out osmate and ruthenate of potash. The residual mass consists chiefly of the oxyds of iridium, rhodium and platinum. These, after distillation with aqua-regia, are brought into the form of double chlorids with ammonium; the iridium reduced to sesquioxyd by means of sulphydric acid, and the platinum separated from the other two metals by washing with a strong solution of sal-ammoniac. The filtrate from the chlorplatinate of ammonium contains iridium and rhodium as sesquichlorids; the iridium is converted by chlorine and nitric acid into bichlorid, and the insoluble chloro-iridate of ammonium separated by filtration from the soluble rhodium salts. This method has given excellent results in the hands of its author but is not free from objection, the chief difficulty lying, in my opinion, in the separation of ruthenium from iridium. The ruthenium salt Ru_2Cl_3,2KCl is scarcely to be distinguished in appearance from the iridium salt $IrCl_2$,KCl; it possesses about the same degree of solubility in water and in solutions of chlorid of potassium and ammonium. By the action of reducing agents the sesquichlorid of ruthenium is reduced, apparently to a protochlorid, the double salts of which, like Ir_2Cl_3,3KCl and Ir_2Cl_3,

* Beiträge zur Chemie der Platin-metalle. Dorpat, 1854.

$3NH_4Cl$, are quite soluble in water. Oxydizing agents readily convert the proto-chlorid of ruthenium into sesquichlorid, which is again precipitated in Claus's process with $IrCl_2,KCl$, in the form of $Ru_2Cl_3,2KCl$. The portion of ruthenium which exists in the mass of double chlorids in the form of $RuCl_2,KCl$ may be easily and almost completely removed by repeated and careful washings with a cold and strong—but not saturated—solution of chlorid of potassium, in which the salt, $RuCl_2,KCl$, is soluble, while the other double chlorids remain undissolved. The small quantity of ruthenium dissolved in washing out the sesquichlorid of iron may be recovered by precipitating the iron carefully with a solution of carbonate of potash, adding a slight excess of chlorhydric acid to the filtrate, and evaporating to dryness, when the ruthenium salt remains mixed with a great excess of chlorid of potassium. In Claus's process however this method is of little use since the greater part of the ruthenium is removed in the form of ruthenate of potash, while another portion remains as $Ru_2Cl_3,2KCl$, insoluble in chlorid of potassium.

Another difficulty in Claus's process arises from the fact that the rhodium salt, $Rh_2Cl_3,3NH_4Cl$, is quite insoluble in a strong solution of chlorid of ammonium, while a weak solution of the same salt dissolves a considerable portion of the iridium and ruthenium salts, $IrCl_2,KCl$ and $Ru_2Cl_3,2KCl$.

Claus's method of separating ruthenium—in the form of Ru_2Cl_3—from iridium, by adding a few drops of ammonia to the neutral solution and boiling so as to precipitate Ru_2O_3+xHO, gives good results when the quantity of ruthenium is large in proportion to the iridium present, but not otherwise. Small quantities of ruthenium cannot be separated at all by this process, nor have I in any case been able to obtain iridium absolutely free from ruthenium by boiling. For these reasons, while doing full justice to the extraordinary skill and success of the Russian chemist, I have still thought the problem of the complete separation of the metals of the platinum group worthy of a new investigation.

The method which I now use consists essentially in the employment of the alkaline nitrites as separating agents; in addition, however, I avail myself, as Claus has so skillfully done, of the different degrees of solubility of the double chlorids of the platinum and alkaline metals.

The relations of the alkaline nitrites to the platinum metals have not hitherto been studied and require special attention in this place. The remarkable double salts which these metals form when treated with the nitrites of potash and soda will be fully described hereafter, but the general character of the salts themselves, upon which my methods of separation are based, may advantageously precede the details of their practical application.

Osmium.—A solution of osmic acid is reduced by addition of nitrite of potash to osmious acid, which unites with the alkali, forming the well known beautiful red salt discovered by Fremy. The solution may be evaporated to dryness without decomposition. The nitrite may therefore be added with great advantage when solutions containing free osmic acid are to be evaporated, or even transferred from one vessel to another. No other reducing agent yet applied answers the same purpose, as the osmium is obtained at once in a very convenient form for preservation. When a solution of osmic acid, to which nitrite of potash has been added, is evaporated sufficiently and then allowed to cool, beautiful garnet red octahedral crystals of the osmite of potash separate. These should be dried *in pleno*, over sulphuric acid, and not in contact with paper or organic matter, which partly reduces the osmious acid to the brown sesquioxyd of osmium. Nitrite of potash exerts no sensible action when boiled with a solution of chloro-osmate of potassium. Any salt which may be formed is very soluble in water.

Ruthenium.—When a solution of nitrite of potash is added in excess to the sesquichlorid of ruthenium, either free or in combination with chlorid of potassium or ammonium, a yellow or orange-yellow color is produced, but no precipitate is formed. A precisely similar change occurs when the ruthenium is in the form of bichlorid, but in this case the change of color is produced more slowly, and usually requires heating or even boiling. The change of color produced is in both cases owing to the formation of an orange-yellow double salt of ruthenium and potassium which is very soluble in water and alcohol; its relations to alcohol in particular enable us to distinguish ruthenium from the other platinum metals more perfectly than has hitherto been possible. Nitrite of soda forms a similar salt with solutions of the bichlorid of ruthenium.

When a few drops of sulphid of ammonium are added to a solution of the ruthenium double salt above mentioned, a magnificent crimson color is produced. This reaction furnishes a characteristic test for ruthenium of the greatest value, since it is not, like Claus's beautiful reactions with sulphocyanid of potassium or sulphuretted hydrogen, materially affected by the presence of the other metals of the same group. The test may be most advantageously applied as follows: The liquid supposed to contain ruthenium is first to be rendered neutral or alkaline by addition of carbonate of soda or potash. I prefer to use an excess of alkali. Nitrite of potash in solution is then to be added, the liquid boiled for an instant, allowed to be become perfectly cold and a drop or two of colorless sulphid of ammonium added. On shaking, the color appears and rapidly deepens to the finest red. When the quantity of ruthenium present is very small, or when large quantities of the other platinum metals are also

present, it is better, after adding the alkaline carbonate and nitrite, to evaporate the whole to perfect dryness on a water-bath and treat the dry and powdered mass with a small quantity of absolute alcohol. The alcoholic solution is then to be filtered off, and tested directly with sulphid of ammonium. In this manner, the smallest trace of ruthenium may be detected, even in the presence of very large quantities of the other platinum metals. A solution of the double nitrite of ruthenium and potassium is completely precipitated by a long continued current of sulphydric acid gas. Sulphid of ammonium also precipitates the solution after a short time, but when added in excess redissolves the dark chocolate-brown precipitate. The addition of a slight excess of dilute chlorhydric acid then completely precipitates the sulphid of ruthenium.

Iridium.—When a solution of nitrite of potash or soda is added to one of chloro-iridate of potassium or ammonium, the color of the solution instantly changes to olive-green, the iridium being reduced from bichlorid to sesquichlorid. The reduction takes place most rapidly in a hot solution, in which it is almost instantaneous. When the solution cools, the new double chlorid usually crystallizes. An alkaline nitrite is a far more elegant and convenient reducing agent for the separation of iridium from platinum than either sulphuretted hydrogen, sulphurous acid or cyanid of potassium. The reduction in question is expressed by the equation,

$$2(IrCl_2.KCl)+KO,NO_3=Ir_2Cl_3,3KCl+NO_4$$

A very different result is however produced when an excess of nitrite of potash is added to a solution containing either of the chlorids of iridium, and the solution is boiled for a few minutes or even allowed to evaporate spontaneously. The olive-green liquid becomes yellow and contains the whole of the iridium in the form of a double salt which is soluble in water but insoluble in alcohol.

When however the solution is boiled, an excess of the alkaline nitrite being present, part of the iridium is thrown down as a heavy snow-white powder, which is insoluble in cold water; hot water dissolves it in small proportion; the solution however speedily becomes milky and remains so for a long time. Chlorhydric acid even on boiling exerts but little action upon it. Nitro-muriatic acid with the aid of heat gradually yields a solution containing bichlorid of iridium. The insolubility of this compound in water and acids is very remarkable, the similar salts of the other platinum metals being nearly all readily soluble either in water or in dilute acids. Nitrite of soda under the same circumstances forms with iridium a soluble orange-yellow salt. The two soluble double nitrites of iridium and potassium or sodium give no precipitate with alkaline sulphids even on

boiling. The soda salt is easily decomposed by boiling with chlorhydric acid, giving a solution of chloro-iridate: the potash salt is decomposed with great difficulty.

Platinum.—Solutions of the alkaline nitrites exert a scarcely sensible reducing action upon chlorplatinate of potassium or ammonium, even after long boiling. The salt retains its color and crystallizes unchanged from the solution on cooling. When other metals belonging to the same group are present, and the solution after adding the nitrite is boiled for some time, a small quantity of platinum is dissolved, giving a yellow salt very soluble in water and alcohol. When nitrite of potash is added to a solution of platinum, sulphid of ammonium immediately throws down a brown precipitate of sulphid of platinum: the same effect is produced in a solution of the yellow salt above mentioned.

Palladium.—A solution of either protochlorid or bichlorid of palladium immediately becomes yellow or orange-yellow, when an excess of nitrite of potash is added to it. Two different double nitrites of palladium and potassium are usually formed in this reaction. Both are soluble and are precipitated in a crystalline form by alcohol from concentrated solutions. One of these salts has a deep orange-red color, the other is lemon-yellow; both are readily soluble in water, and alkaline sulphids precipitate palladium completely from the solutions.

These two salts were first described by Fischer.*

Rhodium.—When nitrite of potash is added to a solution containing the sesquichlorid of rhodium no change is at first produced, but on heating the solution becomes yellow, and on boiling or evaporation to dryness, part of the rhodium is precipitated in the form of a bright yellow or orange-yellow crystalline powder which is extremely insoluble in hot or cold water, but which dissolves readily in hot chlorhydric acid. Another portion of the rhodium usually remains in the form of a yellow salt soluble in water but insoluble in alcohol. The solutions of these two salts are decomposed with great difficulty by boiling with strong acids: alkaline sulphids give a dark brown precipitate of sulphid of rhodium soluble in a large excess of the precipitant and completely precipitated from the solutions by the addition of an excess of chlorhydric acid. Nitrite of soda also gives a soluble and an insoluble salt with solutions of rhodium, but only the soluble salt is formed when the rhodium solution is boiled for a short time with an excess of the alkaline nitrite.

The application of these facts to the separation of the several metals of the group is as follows:

Platinum from iridium.—The separation of platinum from iridium for the purpose of obtaining the two metals in a state of

* Pogg. Ann., lxxiv, 115.

chemical purity may be effected by either of the following processes. The iridium is in the first place to be brought into the form of bichlorid by means of a current of chlorine or by nitric acid, and the two metals are then to be precipitated together as $PtCl_2,KCl$ and $IrCl_2,KCl$, by the addition of a concentrated solution of chlorid of potassium. The color of the mixed salts varies from orange to almost black, according to the quantity of iridium present. The mass of crystals is to be rubbed fine in an unglazed porcelain mortar and boiling water added in the proportion of three volumes of water to one of salt. A dilute solution of nitrite of potash is then to be added, until the liquid becomes deep olive-green, carbonate of potash being thrown in from time to time in quantity sufficient to prevent the solution from becoming strongly acid. The iridium is instantly reduced to sesquichlorid, while the platinum salt remains as a reddish orange powder. The deep olive-green solution is to be poured off and the undissolved mass treated a second time with hot water and nitrite. This process must be repeated as long as the liquid remains olive-green. The mixed solutions on cooling, or after evaporation, deposit a beautiful mass of crystals of the double chlorid of potassium and iridium, $Ir_2Cl_3,3KCl+6HO$. By re-solution and repeated crystallization the iridium salt may be obtained perfectly free from platinum. Instead of nitrite of potash nitrite of soda may be employed in the above mentioned process; the iridium and sodium salt has the formula Ir_2Cl_3, $3NaCl+24HO$, and crystallizes well. The undissolved mass and the mother liquors from the iridium salt contain a large quantity of platinum with a comparatively small quantity of iridium. When the absolute quantity of platinum salt is not very large it may be dissolved in boiling water, a small quantity of an alkaline nitrite added, and the solution allowed to crystallize; the resulting chlorplatinate of potassium contains only a trace of iridium.

The process just mentioned gives satisfactory results when carefully executed but requires attention to two points. In the first place the alkaline nitrite must be added in quantity just sufficient to reduce the iridium from bichlorid to sesquichlorid, but not so as to produce further chemical changes by the formation of the double nitrites of iridium and potassium or sodium. With a very little experience this is easily managed. In consequence of the facility with which the double nitrite of iridium and sodium is decomposed by boiling with chlorhydric acid into the double chlorid $IrCl_2,NaCl$, it is better to use nitrite of soda in the above process, because, in case an excess of nitrite is used, the mixed solution of double chlorid and double nitrite can easily be brought to the form of double chlorid, $Ir_2Cl_3,3NaCl$, by boiling with chlorhydric acid, neutralizing with carbonate of

soda and then reducing the iridium to sesquichlorid by cautiously adding a very dilute solution of nitrite of soda.

In the second place it may happen, as in working with crude platinum solutions obtained, not from osmiridium, but from platinum ores, that the quantity of platinum is very large when compared with that of iridium. The process applies equally well to this case so far as the iridium is concerned, but it is difficult and troublesome to recrystallize large quantities of a salt so insoluble as the chlorplatinate of potassium, $PtCl_2,KCl$, and small quantities of the corresponding iridium salt are difficult to remove. A method of obtaining platinum in a state of chemical purity will be given further on.

The above process is capable of giving chemically pure iridium when platinum is the only other metal present. This is rarely the case and the following method is usually more advantageous. The greater part of the platinum is first to be separated in the manner above pointed out. The solution of double chlorid of iridium and sodium, $Ir_2Cl_3,3NaCl$, is then to be filtered, an excess of nitrite of soda added and the solution boiled until it assumes a clear orange-yellow color. To the boiling solution sulphid of sodium is to be added drop by drop as long as this produces a cloudiness and until a small quantity of the precipitated sulphid of platinum, PtS_2, is redissolved. Dilute chlorhydric acid is then to be added cautiously until the liquid, previously allowed to become cold, is distinctly though faintly acid, when it is to be filtered and the sulphid of platinum on the filter washed continuously with hot water. The filtrate is then to be boiled with chlorhydric acid in excess, and the resulting chloro-iridate of sodium evaporated, precipitated by a cold and strong solution of chlorid of ammonium, and washed with the same. This salt on ignition yields pure iridium, if the operation has been well conducted. It is in all cases however well, after separating the sulphid of platinum by filtration, to neutralize the filtrate with carbonate of soda, boil a second time with a little additional nitrite of soda and then add sulphid of sodium and proceed as before. In this manner every trace of platinum is removed and the resulting iridium salt is chemically pure.

Platinum from ruthenium.—Ruthenium in the form of bichlorid may be approximately separated from platinum by precipitating the two metals together in the form of $PtCl_2,KCl$, and $RuCl_2,KCl$, and washing out the ruthenium salt with cold water in which it is readily soluble. The mixed solutions should be evaporated to dryness with an excess of the alkaline chlorid and the dry mass rubbed to fine powder in a mortar, after which almost the whole of the ruthenium may be washed out with water or with a cold and moderately strong solution of chlorid of potassium. The undissolved platinum salt may then be puri-

fied by crystallization but usually retains traces of ruthenium. The rose-red solution of the ruthenium salt contains a small quantity of platinum from which it cannot be wholly freed by the difference in solubility of the two salts. Chlorid of ammonium may be employed in this process in place of chlorid of potassium.

To obtain a complete separation the following process may be followed with advantage. The chloro-ruthenate of potassium, separated as far as possible from the platinum salt, is to be heated with a solution of nitrite of potash in quantity sufficient to convert the whole of the ruthenium into the soluble yellow double nitrite of ruthenium and potassium, carbonate of potash being added in small quantities so as to keep the solution neutral or alkaline. The yellow or orange solution is to be evaporated to dryness in a water bath, the dry mass reduced to powder and boiled with absolute alcohol until the ruthenium salt is completely dissolved. This is best effected in a flask furnished with a condensing tube bent upward so that the alcohol vapors may be condensed and flow back into the flask. The boiling need not be continued for a very long time as the ruthenium salt is readily soluble in alcohol. The solution is then to be filtered off from the undissolved salts and these are to be washed with absolute alcohol until the washings are colorless, or until they no longer give the characteristic ruthenium reaction with sulphid of ammonium. The filtrate and washings may then be distilled to separate and save the alcohol, water being first added in small quantity. The residue in the retort or flask is then to be evaporated with chlorhydric acid which readily decomposes the double nitrite and yields a fine deep rose-red solution of the chloro-ruthenate of potassium, containing at most only a trace of platinum. The mass of salts undissolved by the alcohol contains nearly all the platinum in the form of chlorplatinate of potassium which is easily separated. The solution of chloro-ruthenate of potassium is now so pure that it gives the reactions of a chemically pure salt. To obtain the ruthenium in a state of absolute purity the solution is to be evaporated to dryness with a saturated solution of sal-ammoniac in excess, redissolved, again evaporated and the dry mass washed with a little cold water to remove the alkaline chlorids. The chloro-ruthenate of potassium is in this manner, for the most part at least, converted into chloro-ruthenate of ammonium. This salt is then to be dissolved in hot water, a solution of ammonia added, and the liquid boiled until it assumes a clear yellow or orange-yellow color, after which it is to be evaporated to dryness upon a water-bath. In this manner the ruthenium is converted into the chlorid of ruthen-diamin, $2NH_3,RuCl+3HO$, discovered by Claus. The yellow mass is to be dissolved in boiling water and a solution of chlorid of mercury added. A

beautiful yellow crystalline double salt is precipitated, and the mother liquor, when cold, contains only traces of ruthenium and platinum. The double chlorid of mercury and ruthen-diamin has the formula $2NH_3,RuCl+HgCl$; it is almost insoluble in cold water, but is soluble in boiling water and is easily rendered absolutely pure by recrystallization. On ignition this salt yields chemically pure metallic ruthenium as a silver-white porous mass. When, in a mixture of solutions of ruthenium and platinum, the ruthenium is present either partly or wholly as sesquichlorid, the liquid is to be boiled with nitrite and carbonate of potash as above, evaporated to dryness, boiled with excess of chlorhydric acid to convert the double nitrite of ruthenium and potassium into chloro-ruthenate of potassium, $RuCl_2,KCl$, and the resulting solution treated by the process already described.

Platinum from rhodium.—The separation of these metals may be approximately effected by bringing the platinum into the form of $PtCl_2,KCl$ or $PtCl_2,NH_4Cl$, and the rhodium into that of $Rh_2Cl_3,3KCl$, or $Rh_2Cl_3,3NH_4Cl$, and then carefully washing out the rhodium salt by small successive portions of cold water, or better of a moderately concentrated solution of chlorid of potassium or ammonium. This is the method usually employed. By recrystallizing the platinum and rhodium salts respectively they may be obtained in a state of purity, since they are not isomorphous. To obtain rhodium absolutely free from platinum it is best to convert the two metals into the ammonium double salts, separate the rhodium salt as completely as possible by washing with a solution of sal-ammoniac and then evaporate the double chlorid of rhodium and ammonium with a solution of ammonia. In this manner the rhodium is converted into the chlorid of the ammonia-rhodium base discovered by Claus, $5NH_3,Rh_2Cl_3$, while the platinum forms no well defined or crystallizable compound. The chlorid of Claus's base may then be purified by repeated crystallization.

Iridium from ruthenium.—The separation of these metals cannot be effected by igniting them with a mixture of saltpeter and caustic potash. Under these circumstances the ruthenium is oxydized to ruthenate of potash, but a portion of the iridium also becomes soluble in the alkali, though in what state of oxydation it is difficult to ascertain. Moreover the complete oxydation of a mixture of the two metals, even when in a finely divided state, can hardly be effected by a single fusion. Claus has given no general method for the separation of iridium and ruthenium in the wet way. In his method of treating the Siberian ores the greater part of the ruthenium is separated as ruthenate of potash by the primary fusion with saltpeter and caustic potash, but a portion always remains with the iridium and is difficult to remove, especially as, after solution in chlorhydric acid, salts of both ses-

quichlorid and bichlorid of ruthenium are invariably present. No part of the present investigation has cost more labor than the complete separation of iridium and ruthenium, the properties of mixtures of the salts of these metals having sometimes almost led to a conviction of the existence of new metallic elements in the osmiridium.

A perfect separation of ruthenium from iridium may be easily effected by the following process which is applicable to all cases, without reference to the state of oxydation in which either metal may exist. To the solution containing the two metals nitrite of soda is to be added in excess, together with a sufficient quantity of carbonate of soda to keep the liquid neutral or alkaline. The whole is to be boiled until the solution assumes a clear orange-yellow or orange color. If a green tint should be perceptible more nitrite of soda must be added and the solution again boiled. Both ruthenium and iridium are converted into soluble double nitrites. A solution of sulphid of sodium is then to be added in small quantities at a time until a little of the precipitated sulphid of ruthenium is dissolved in the excess of alkaline sulphid. The first addition of the sulphid gives the characteristic crimson tint due to the presence of ruthenium, but this quickly disappears and gives place to a bright chocolate-colored precipitate. The solution is then to be boiled for a few minutes, allowed to become perfectly cold, and then dilute chlorhydric acid added cautiously until the dissolved sulphid of ruthenium is precipitated and the reaction is just perceptibly acid. The solution is then to be filtered through a double filter, and the sulphid of ruthenium washed continuously and thoroughly with boiling water. The filtrate is perfectly free from ruthenium: it is to be evaporated with chlorhydric acid and treated with sal-ammoniac in the manner already pointed out in speaking of the separation of iridium from platinum. The washed sulphid of ruthenium is to be treated together with the filter with strong chlorhydric acid and chlorid of ammonium added in quantity sufficient to form chloro-ruthenate of ammonium. Nitric acid is to be added from time to time in small quantities until, with the aid of heat, the whole of the sulphid of ruthenium is oxydized and dissolved. The liquid is then to be filtered, the filter well washed and the filtrate and washings evaporated to dryness on a water-bath, when, after washing out the soluble salt with a strong solution of chlorid of ammonium the salt, $RuCl_2,NH_4Cl$, remains almost chemically pure. It is to be dissolved and converted into the compound of chlorid of mercury and ruthen-diamin, $2NH_3RuCl+HgCl$, by the process already described. From this salt chemically pure ruthenium may be obtained by ignition, which is best effected in an atmosphere of hydrogen, as the reduced metal is easily oxydized in the air.

It may happen that the precipitated sulphid of ruthenium contains traces of iridium. This can only arise from imperfect washing or want of proper care in precipitating with sulphid of sodium. In this case the washings from the chloro-ruthenate of ammonium are yellow and contain sulphate of iridium, probably $Ir_2O_3, 3SO_3$. The quantity of iridium in such cases is too small to be worth the trouble of separate treatment.

When a solution contains iridium and ruthenium in the form of bichlorids, the ruthenium may be easily and completely separated by boiling the solution with nitrite of potash in excess, adding at the same time enough carbonate of potash to give an alkaline reaction, evaporating to dryness and dissolving out the double nitrite of ruthenium and potassium by means of absolute alcohol, in the manner recommended for the separation of ruthenium from platinum. The undissolved mass in this case contains the two double nitrites of iridium and potassium. By adding a strong solution of chlorid of ammonium, evaporating to dryness, igniting the dry mass in a porcelain crucible, and dissolving out the soluble salts, metallic iridium remains in a state of purity. This method may be used for the quantitative separation of iridium from ruthenium, but when the object is simply to prepare both metals in a state of chemical purity I prefer the separation by means of sulphid of sodium.

Iridium from rhodium.—Iridium may be approximately separated from rhodium by the process recommended by Claus, which consists in taking advantage of the solubility of the double chlorid of rhodium and ammonium, $Rh_2Cl_3,3NH_4Cl$, in moderately strong solutions of chlorid of ammonium in which chloro-iridate of ammonium is nearly insoluble. This method is difficult of application when the quantity of rhodium is small, and is at best tedious and unsatisfactory. A better method is that given above for the separation of iridium from ruthenium. The mixed solutions of iridium and rhodium are to be treated as above mentioned with nitrite of soda, the rhodium precipitated by sulphid of sodium in slight excess, the liquid rendered slightly acid, filtered and the dark brown sulphid of rhodium thoroughly washed. The filtrate is perfectly free from rhodium and is to be treated in the manner already described. The sulphid of rhodium is to be oxydized in the same manner as the sulphid of ruthenium and converted into the double chlorid of rhodium and ammonium, $Rh_2Cl_3,3NH_4Cl$, which is insoluble in a cold saturated solution of sal-ammoniac, in which it may be washed once or twice to remove alkaline salts and any traces of iridium which may be present as sulphate. The rhodium salt is then to be purified by crystallization, or converted into the chlorid of Claus's rhodium-ammonia base by evaporation on a water-bath with a solution of ammonia. The sulphate of iridium, $Ir_2O_3,3SO_3$, does not give

a basic compound under these circumstances. The chlorid $5NH_3$, Rh_2Cl_3, is then to be further purified by crystallization.

Rhodium from ruthenium.—The separation of rhodium from ruthenium is best effected by means of nitrite of potash. The mixed solution of the two metals is to be boiled for a short time with an excess of the nitrite together with a little carbonate of potash to keep the solution neutral or slightly alkaline. The yellow or orange-yellow solution is then to be evaporated to dryness upon a water bath, the dry mass rubbed to fine powder and then treated in a flask with absolute alcohol in the manner pointed out for the separation of platinum from ruthenium. After filtration and washing with absolute alcohol, the rhodium remains undissolved in the form of a mixture of the two double nitrites of rhodium and potassium. These may be ignited with a large excess of sal-ammoniac so as to yield, after washing, metallic rhodium, or the nitrites may be dissolved in hot chlorhydric acid, ammonia added, and the rhodium precipitated as sulphid, which is then treated in the manner already pointed out, so as to convert the rhodium into the double chlorid of rhodium and ammonium. To remove the last traces of ruthenium the rhodium salt may be a second time treated with nitrite of potash, as above, and again washed with alcohol. The presence of the least trace of ruthenium is easily detected by adding a drop of colorless sulphid of ammonium to the alcoholic solution. The method of obtaining pure ruthenium from the double nitrite of ruthenium and potassium has already been given.

For the separation of osmium from the other metals of the group I have no better method to offer than that which is universally employed, namely, the volatilization of the osmium in the form of osmic acid. The separation of palladium is in all cases also best effected by the processes commonly employed, especially by taking advantage of the solubility of the double salts of protochlorid of palladium in solutions of the alkaline chlorids.

With these preliminary and general statements the method which I employ in separating the different metals of the platinum group from each other will be intelligible. The mass of double chlorids, obtained as already mentioned, is to be rubbed to a fine powder; introduced into a deep porcelain evaporating dish and mixed with four or five times its volume of boiling water. A solution of nitrite of soda is then to be added in small quantities at a time, the solution being continually stirred and occasionally neutralized by addition of carbonate of soda. The liquid soon becomes olive-green and the greater part of the mass dissolves: it is advantageous, when the quantity of the mixed chlorids is large, to pour off the liquid as soon as it appears saturated and to repeat the operation with a fresh quantity of water.

The undissolved mass, which consists chiefly of the impurities of the ore, when these have not been removed before the process of oxydation, is then to be thrown upon a filter and washed with boiling water until the washings are colorless. By keeping the solution somewhat alkaline the whole of the iron remains upon the filter as sesquioxyd with the other impurities. The filtrate contains iridium and rhodium as sesquichlorids, ruthenium partly as bichlorid and partly as protochlorid, platinum as bichlorid. When the operations already mentioned have been well performed, no determinable quantities of osmium and palladium are present. On cooling the greater part of the platinum is deposited as $PtCl_2,KCl$, mixed with a little of the corresponding iridium salt, and is to be separated by pouring off the olive-green supernatant liquid. The quantity of the alkaline nitrite to be added in this process need not exceed half of the weight of the mass of double chlorids, but with a little experience it will be found unnecessary to weigh the nitrite added, the process of the reduction of the iridum salt, $IrCl_2KCl$, being evident to the eye.

To the filtrate a solution of nitrite of soda is to be added and the whole boiled until the liquid assumes a clear orange color. Nitrite of soda should be used in this process because the resulting double nitrite of iridium and soda is easily decomposed by boiling with chlorhydric acid, which is not the case with the potash salt. When nitrite of potash is used a small quantity of the white insoluble double salt already mentioned is usually formed and renders the solution turbid.

To the clear yellow or orange-yellow boiling solution sulphid of sodium is to be added until a portion of the dark brown precipitate of the sulphids of ruthenium, rhodium and platinum is dissolved with a brown-yellow color, and an excess of the alkaline sulphid is consequently present. The liquid is then to be allowed to cool and treated with dilute chlorhydric acid until a distinctly acid reaction is produced. In this manner the whole of the platinum, ruthenium and rhodium present in the solution are thrown down as insoluble sulphids. After complete subsidence the sulphids are to be thrown on a double filter and thoroughly and continuously washed with boiling water. When the operation is carefully performed the filtrate and washings contain only iridium. It is best to neutralize this solution with carbonate of soda, boil a second time with a little additional nitrite of soda and treat as before with sulphid of sodium and chlorhydric acid. In this manner very small additional quantities of the sulphids of platinum, ruthenium and rhodium may sometimes be separated.

The filtrate is to be evaporated and boiled with an excess of strong chlorhydric acid which completely decomposes the double nitrite of iridium and soda, yielding the salt, $IrCl_2,NaCl$, which is very soluble in water. An excess of a pure and strong solution of chlorid of ammonium is then to be added, the whole evaporated to dryness, and the dry mass washed with cold water and then with a cold and strong solution of the ammonium salt. There remains a mass of pure chloro-iridate of ammonium which may be advantageously rubbed to a fine powder, dissolved in boiling water and allowed to crystallize. The resulting salt is chemically pure and the crystals possess an extraordinary beauty and lustre. The mass of mixed sulphids together with the filter are to be treated with strong chlorhydric acid, and nitric acid added in small portions at a time. By the aid of a gentle heat the sulphids are readily oxydized and dissolved. After sufficient dilution the liquid is to be filtered, the pulp of undestroyed filter paper washed, the filtrate evaporated to dryness, the dry mass digested with concentrated chlorhydric acid and again evaporated to dryness. The dry mass of chlorids and sulphates is to be redissolved in water and the platinum, ruthenium and rhodium precipitated by metallic zinc, after addition of chlorhydric acid. The finely divided metals after filtration washing and drying, are then to be mixed with chlorid of potassium and treated with dry chlorine at a low red heat. In this manner the metals are again brought into the form of double chlorids and the difficulties which arise from the presence of the sulphates are avoided.

The mixed double chlorids are to be boiled with nitrite of potash, evaporated to dryness, and the soluble nitrite of ruthenium and potassium dissolved out with absolute alcohol in the manner described in speaking of the separation of platinum from ruthenium. The ruthenium may then be obtained pure by converting it into the double chlorid of mercury and ruthendiamin already mentioned.

The mass undissolved by alcohol consists of chlorplatinate of potassium mixed with both the soluble and the insoluble double nitrites of rhodium and potassium. It is to be boiled with dilute chlorhydric acid, neutralized with carbonate of potash, again evaporated to dryness, after the addition of nitrite of potash, and again boiled with absolute alcohol which sometimes dissolves a trace of ruthenium. The undissolved mass is then to be treated with hot water and again evaporated to dryness, and this process repeated two or three times so as to convert the whole of the soluble rhodium salt into the insoluble salt. The chlorplatinate of potassium may then, after reducing the mass to fine powder, be dissolved out by boiling water, when the rhodium salt remains pure as a fine orange-yellow crystalline powder. This may be

dissolved in hot chlorhydric acid, evaporated to dryness with an excess of pure chlorid of ammonium and ignited in a clean porcelain crucible, when pure metallic rhodium remains as a porous mass mixed with chlorid of potassium.

When the process above described has been carefully conducted, and especially when the quantity of nitrite of soda added is sufficient, the mixed sulphids will be found to contain only platinum, rhodium and ruthenium, and to be free from iridium. If however, after converting the sulphids into double chlorids in the manner pointed out, iridium is found to be present, the process to be pursued is still the same so far as regards the separation of the ruthenium; the remaining mass is then to be dissolved in water with addition of chlorhydric acid, the solution nearly neutralized with ammonia, the platinum and rhodium separated as sulphids in the manner already pointed out, brought into the form of double chlorids and then separated by nitrite of potash as before.

For the complete success of this method it is absolutely necessary that the mass of mixed double chlorids be freed from osmium as completely as possible. This is to be done in the usual manner by repeated evaporation with nitro-muriatic acid.

In place of the method above given the following may also be employed with success and are sometimes more convenient.

(To be continued).

Art. XXXI.—*Geographical Notices.* No. XVIII.

RETURN OF HALL'S ARCTIC EXPEDITION.

The latest, it is doubtful whether we can say the last, of the Arctic explorers has safely returned to this country. We learn that at an early day he is to present the results of his explorations in a paper to be read before the American Geographical Society, which will undoubtedly be printed. Meanwhile, we owe the following sketch of his journey to one of his advisers and friends, a public spirited gentleman in New London.

It may be recollected that in the year 1860, Mr. C. F. Hall, of Cincinnati, planned and started an expedition, on a plan somewhat novel, for the purpose of exploring the regions north and west of Hudson's Straits, in British America, and to discover if possible further relics and remains of the lost and mourned Sir John Franklin and his crews.

The peculiarity of Mr. Hall's efforts were that dispensing with vessels, men, provisions, fuel, &c., he proposed a journey over the trackless snow-fields *alone*, or with companions found among the roving Esquimeaux, whose habits and mode of life he pro-

posed to adopt to the extent that should render him as independent as they.

Aided by a few friends, supplied with a boat, a few necessary scientific instruments, guns and ammunition, he sailed as passenger in the whaling Bark George Henry, of New London, Ct., June 29, 1860, for the scene of his labors.

The vessel in which he took passage prosecuted her voyage on the west side of Davis Straits, and remained during her stay in a small bay situated in N. lat. 62° 52′, W. long. 65° 05′. From this point Mr. Hall proposed, on starting, a journey far west, but owing to the accidental loss of his boat and the death of an intelligent interpreter, the original plan was abandoned, and he confined his researches to the country adjacent—going over and minutely examining an area of some three hundred miles west, and about seventy-five miles south from the place of starting. This area of country so far as our knowledge extends has not been seen or examined by any white man since the years 1573–6.

Hakluyt's Voyages, published in London in the year 1600, gives an account of the voyages of Sir Martin Frobisher to these regions where he discovered a Strait bearing his name and attempted to found a colony. An examination of the English Admiralty Chart of 1853, sheet one, or the fine American Chart from the United States Hydrographic Office, published with the volume of the Grinnell Arctic Expedition under Lieut. DeHaven, will show in faint outline the so-called Frobisher's Straits, supposed to afford a passage from the ocean westward to the further part of Hudson's Straits. Navigators however have always chosen the latter in passing to and from Hudson's Bay and vicinity, and it may be well that they have done so, for the travels of Mr. Hall have proved this to be not a strait but a bay or inlet, similar to Cumberland Inlet, just north on the same coast. This Frobisher's Bay, as we must now call it, is a noble sheet of water. Mr. Hall, with dog-team sledges in winter and boats in summer, coasted the entire circuit of it, examining every nook and corner, finding the main headlands and islands of the eastmost part to correspond with the descriptions of the ancient navigator; he found also indubitable proofs of the temporary settlement of the whites nearly three hundred years ago, and heard among the Esquimeaux well authenticated traditions of their attempt and its failure.

The entrance to this bay is just north of Resolution Island, at the mouth of Hudson's Straits,—a large island nearly blocks the passage, but once past this it stretches away west-northwest about two hundred miles, with an average width of about fifty miles. Numerous islands stud the coasts; an immense glacier is on the southern side, a mountain full of fossils at the western ex-

tremity, and bones of the whale and walrus bleach on the dark rocks up and down the shores. The waters and adjacent land abound with animal life—bears, deer, rabbits, ducks, birds, whale, walrus, seal and fish are numerous in their seasons. The native inhabitants from long distances resort here to fish and hunt, and all things considered it may be called a favored locality for such dreary regions—for about eight months of the year ice and snow are masters of the field.

Mr. Hall spent about twenty months in and about this region. He brings home a carefully prepared chart showing his discoveries and travels, also many relics and curiosities of the country. He has learned the Esquimeaux language and formed many friends among this simple-hearted and generous people. He proposes, by a volume or public lectures, to give the details and incidents of his journey, some of which have a romantic and thrilling interest.

Mr. Hall proposes to prosecute another voyage northward. By perseverance and pluck he has accomplished much that may prove of interest to the cause of science. Such energy should meet a suitable reward. R. H. C.

Anniversary of the Royal Geographical Society.—At this meeting, held in May last, the retiring President, Lord Ashburton, delivered an address, from which we make several extracts, containing more full and exact information than has reached us from any other source. Sir R. I. Murchison succeeds Lord Ashburton as President.

The Founder's Gold Medal was awarded to the representative of Richard O'Hara Burke, in remembrance of that gallant explorer, who with his companion Wills perished after having traversed Australia from south to north. A gold watch was also awarded to Mr. John King, the sole survivor of the expedition under Burke. The Patron's Gold Medal was awarded to Capt. Blakiston, R. A., for the survey of the River Yang-tze-Kiang, from Yo-chow to Ping-shan, extending nine hundred miles beyond the farthest point previously reached by Englishmen. We quote the following information from the address.

1. Ordnance Survey of Great Britain and Ireland.—The publication of 'The Trigonometrical Survey of the United Kingdom' is now completed, and is comprised in seven quarto volumes, viz.:—

I. The Principal Triangulation, with the Figure, Dimensions, and Mean Specific Gravity of the Earth derived therefrom, 2 vols.

II. Levelling, taken in Ireland, 1 vol.

III. Levelling, taken in England and Wales, 2 vols.

IV. Levelling, taken in Scotland, 2 vols.

Thus this great work, which was commenced in 1783, under General Roy, R.E., is at length finished.

In last year's estimates the sum of 1000*l.* was taken to enable the director of the survey to extend the triangulation of England through France to the frontiers of Belgium, so as to form a connection between the triangulations of England and Belgium. This operation has been completed. The stations selected to form the connection across the Channel were St. Peter's Church, between Margate and Ramsgate; Coldham, on the high ground north of Folkestone; and Fairlight, a few miles north of Hastings. From these three stations observations were taken to the church at Gravelines, to Mont Couple, near Wissant, and Mont Lambert, near Boulogne.

From these three last named stations a station raised 74 feet above the level of the ground at Harlettes, between Boulogne and St. Omer, was observed, and then the churches at Cassel and Dunkirk, and then the station at Mont Kemmel, near Ypres, in Belgium. The triangle, Dunkirk, Cassel, and Mont Kemmel, is common to the triangulations of France and Belgium, and is now also made part of the extended triangulation of this country, and the lengths of its sides will therefore be independently determined by the geometricians of the three countries from the measured bases in the three countries, and a comparison of the results will be highly interesting; but the French officers who were ordered to observe at the same stations that ours were observed at, not having been able last year to take the observations across the Channel, the comparison cannot yet be made. They have now, however, returned to this country to recommence their work, and it is to be hoped they will be able to finish it this summer.

During last year the Belgian geometricians were engaged in connecting their triangulations with that of Prussia, and the Prussians in connecting theirs with that of Russia; and thus we shall shortly have a connected triangulation, extending from the west of Ireland to the Oural mountains, and the means of computing the length of an arc of parallel of about 75° in length.

The electric telegraph now furnishes the means by which the difference of longitude between distant places can be determined with greater precision than they could formerly be by the transmission of chronometers from one station to another.

The Astronomer Royal will therefore this year re-determine the difference of longitude between Valentia, in the S.W. of Ireland, and the observatory at Greenwich, by means of the electric telegraph; and as it will be necessary for the director of the survey to connect the station selected by the Astronomer Royal at Valentia with the triangulation of the kingdom, a joint expedition is now about to proceed to Valentia for this double purpose, and to complete the quota of work assigned to us for the measurement of this great arc of parallel.

The engraving of the complete map of Ireland in outline, on the scale of one inch to a mile, was finished last year, and the hill features are now being engraved. There are 205 sheets in this map.

The progress of the Cadastral Survey in the north of England and Scotland has been greatly retarded in consequence of the very numerous and extensive surveys which have been made by the Ordnance in the south of England for the purposes connected with the defenses of the kingdom.

But as all these have been made on the scales adopted for the National Survey, and the plans have been drawn as so many sheets of a complete survey of the counties to which the places belong, they will form a part of the Cadastral Survey of England and Wales, should such a measure be decided on; and as the committee of the House of Commons, of which Lord Bury was chairman, which was appointed last year to report upon "the expediency of extending the Cadastral Survey to those portions of the United Kingdom which have been surveyed upon the scale of one inch to a mile only," have reported in favor of it, the cost of the surveys made for the defenses will go to diminish the cost of the Cadastral Survey.

In the north of England, Yorkshire and Lancashire have been published on the 6-inch scale; Westmoreland and Durham on the 25-inch scale; and the survey is in progress in Northumerland and Cumberland. A large portion of each of these counties has already been published, and they will be finished this year. The last sheets of the 1-inch map of England and Wales are in the hands of the engravers; we may, therefore, expect that this map, which was begun in 1784, will now be soon finished. In Scotland all the southern counties have been published either on the 25-inch or 6-inch scales; and the counties of Forfar, Perth, Stirling, and Dumbarton are in course of publication; and the survey is proceeding in Perthshire, Kincardineshire, and Buteshire. The 1-inch map of Scotland is also in course of publication.

The plans of the eight northern counties of Ireland have been revised and made perfect in every detail, like the plans of the southern counties. This perfect revision was rendered necessary to enable the Government valuators to mark upon the plans every property and tenement: and this has now been done throughout the whole of Ireland. The Ordnance plans are now invariably used for the transfer of land under the Landed Estates Court, the cost of preparing the plans for the court being charged to the carriage of the sale of the property; and the same arrangement will doubtless be introduced here as soon as some progress is made in the Cadastral Survey.

Sir Henry James has this year published six sheets of the Marginal Lines for the sheets of a map of the whole world, on the scale of 2 inches to a mile; the object in view being to have a map constructed on the largest scale required for geographical purposes, the sheets of which can be put together to form a connected map of any part of the world, however large or however small; and to avoid the confusion arising when we attempt to put together maps of different countries, as they are now constructed on different scales and on different projections.

This is a great undertaking, and one which will require the coöperation of a great number of people and some years to accomplish; but the advantages to be derived from having such a grand map of the world are obvious; and it is right that the topographical department of such a country as ours should undertake to make it.

In a discussion upon the relative merits of several projections for large portions of the earth's surface which has been published in the last number of the 'Philosophical Magazine,' it has been demonstrated, that, assuming the errors which all projections of a spherical surface on a plane

must necessarily have, viz., distortion in form and distortion in area, are equally objectionable, the distance of the point of projection adopted by Sir Henry James in his geometrical projection of two-thirds of the sphere, will, for the projection of a hemisphere, give the least possible distortion of form and area, and that the misrepresentation will be a minimum. If we draw a circle and two diameters in it at right angles to each other, one may be taken to represent the plane of projection for the concave hemisphere above it, and the point of sight or projection is at the distance of half the radius in the prolongation of the other beyond its circle. It is now demonstrated that this is the best possible projection for a hemisphere, and it should therefore be adopted by all geographers.

2. Topographical Survey of Spain.—We learn from our correspondent, M. Coello, the accomplished geographer, who is now directing the topographical survey of Spain, that the following additions to our science have recently been made.

During the year 1861 persevering progress has been made in the great triangulation of the country.

All the chains of the triangles of the first order have already been studied, including those which relate to the whole circumference of the kingdom.

The chains of the meridian of Madrid, both to the north and to the south of that capital, have nearly all been measured, and will be completed before the end of the present year.

The parallel of Madrid to the west has been finished as far as the frontier of Portugal; and the measurement of the triangles of the parallel of Ciudad Real to Badajoz has been commenced. The triangles required to complete the spaces to the west of the meridian of Madrid have been laid down as far as that of Salamanca.

The triangulation of the second order is finished for the whole province of Madrid, as well as that for a part of the adjacent country. We are now only waiting for the results of the last calculations for compensation, which have just been completed, in order to fix the length of the great base of Madridejos, and begin the long calculation of the work which has been done.

This year these different undertakings will be continued, and signals will be fixed for the measurement of the parallel to the east of Madrid, with the intention of making, concurrently with this work, simultaneous and reciprocal observations to determine the geodistic level, and settle with accuracy the elevation of Madrid above the Mediterranean, presumed at present upon the most received existing calculations to be 660 mètres, which is, perhaps, within ten inches of the truth.

The topographical labors thus undertaken in the province of Madrid will be continued during the year. The corresponding land registration will at the same time be proceeded with, and the levels will be very carefully taken.

The maps are on the scale of $\frac{1}{10000}$, and of $\frac{1}{500}$ for cities and buildings. The classifications, territorial valuations, and dispositions in the public archive, will commence as soon as a portion of the province is completed. The topography is executed with very great accuracy.

During the past year a portion of the Tagus, and its tributary the Gallo, has been mapped to form a portion of the hydrography of Spain.

The geological department has completed its work in the provinces of Burgos, Santander, and Madrid, and has commenced with those of Leon, Zamora, and Avita.

In the department of Woods and Forests various topographical details have been obtained in the provinces of Santander, Burgos, Valencia, Asturias, Oviedo, and Leon.

All these works have been executed under the direction of the Funta-General of Estadistica, who is appointed by the Government to take charge of scientific researches regarding the Spanish territory.

3. Khanikoff's Researches in Persia.—The Russian traveller, N. de Khanikoff, who has been engaged in making up the deficiencies in our imperfect knowledge of the Aderbeijan, in Persia, has made a new map of that region, which he has had engraved at Berlin. He has distributed several copies of it, and transmitted his observations regarding that interesting mountain district to the Academy of Sciences in Paris, and also to our secretary, Dr. Shaw, for the use of the Royal Geographical Society.

An uncommon degree of regularity characterizes the mountain-ranges of this province of Persia, which is bounded both on the east and on the west by lofty longitudinal ridges. To the east the Talish mountains separate it from the basin of the Caspian; and to the west the chain of Kandilar forms a barrier between it and Mesopotamia. To the north and to the south of the Aderbeijan these two chains are joined by longitudinal elevations: the one, commencing at Mount Savalan (of 4752 mètres), joins the Kandilan chain in Kurdistan: the other, coming off from the Talish mountains, and known as the Buzgush chain, joins Mount Sehend (of 3505 mètres). The space included between Mount Savalan and the Talish chain of mountains is occupied by the plain of Mughan, and the Salt Lake of Urmia is situated in the region lying between the Sehend and the Kandilan chain. The lowest point of this part of Persia, that is to say, the level of the Lake of Urmia, is 1250 mètres above the level of the sea; and the highest point in the province of Aderbeijan is the summit of Ararat, 5169 mètres high. The line of perpetual snow varies in elevation from 3600 to 3800 mètres. This regular arrangement of the surface of the district, and the character of the climate, dependent on its high position, are very favorable for topographical work. The state of the atmosphere is generally so clear that one is never long without being able to see some one of the lofty summits which serve as landmarks for reference; and it rarely happens that mirage or dry fog interrupts the distinct vision of objects for an entire day. Notwithstanding the precision with which the skillful topographers from amongst the officers of the Caucasus who acted under his orders, as well as himself, endeavored to execute the work of laying down the itineraries of detached regions, it would be impossible to combine these independent labors without the basis of some well-determined astronomical geometrical observations. These happily were not wanting, as he had latitudes and longitudes in Persia which had been settled by M. Lemm, and the results of the triangulation of the Caucasus under the direction of Gen. Chosdzko. The former gave a series of fixed points in the neighborhood of the Araxes; and the latter supplied the like data, rigorously established, be-

tween Erivan and the basin of the Caspian. Hence the localities given in the north and middle of Khanikoff's map have their exact bearings; and it is only in the south that he had no other data than such as were obtained by azimuths measured with the help of the magnetic needle. The errors to which such observations are necessarily liable will be corrected when the Anglo-Russian commission for defining the Turkish and Russian boundary shall have published its numerous astronomic data.

That part of the map which is strictly new is the southern portion, in which is situated the Lake Urmia, with its islands; the itinerary from Marand to Khoi: and the topographical details in the two provinces of Persian Kurdistan, Lahijan and Ushnu, in which he had the good fortune to complete the researches of his predecessors, Generals Monteith and Rawlinson.

4. Various recent English Surveys in China.—Geography is already beginning to share in the advantages derivable from Lord Elgin's treaty, the conditions of which so greatly improve the position of the foreigner in China, whether traveller or official, merchant or missionary. Until that treaty came into operation, our countrymen could only penetrate the interior of this vast country in the face of legal prohibitions, and with the liability of arrest at the hands of the native authorities. The new treaty gives British subjects the right of travelling with a passport through the whole land, and so readily has this permission been availed of, that, in the first year after this right was obtained, twelve out of the eighteen provinces of China have been visited by our countrymen, together with Manchoo Tartary, the cradle of the present dynasty.

First among these explorations comes the ascent of the Yang-tze-Kiang, so gallantly undertaken by Colonel Sarel, Captain Blakiston, Dr. Barton, and Mr. Scheresheffsky, the details of which are familiar to us all; while the high sense entertained by this Society of the services these gentlemen have rendered to geography has been marked, as you have seen this day, by the presentation of the Patron's Medal to Captain Blakiston. In tracing the great Yang-tze along 1800 miles of its course, those travellers crossed the six central provinces of Keangsoo, Nganhwuy, Keangse, Hoopih, Hoonan, and Sze-chuen; and thus carried their explorations upwards of a thousand miles beyond any point that had previously been openly visited by foreign travellers. The first 700 miles of that river's course is now made familiar to Europeans by the opening of the port of Hankow to foreign commerce, and there is every prospect of the high expectations that have been formed of the capacity of that great central mart being fully realized. Within eight months of the opening of that port it had been visited by nearly 200 foreign craft, consisting for the most part of small steamers; and the foreign trade thus conducted amounted during the first six months to two millions sterling.

Some particulars of no less than seven other journeys, undertaken by our countrymen in the north, centre, and south of China during the past year, have been made public. In the north, Mr. Morrison, our Consul at the new port of Chefoo, with Captain Harcourt as his companion, travelled over land to his post from Teentsin in the month of January, and profitted by the opportunity thus afforded him to follow the Grand Canal

along nearly 300 miles of its track, to visit the tomb of the great sage Confucius, which is to be seen at Kewfoo, in the charge of his own descendants, a family with a pedigree of 2500 years, dating from the time of the sage himself. Mr. Morrison also visited Tsenan, the capital, and other places in the hitherto unexplored province of Shantung, and the journey took these travellers over 700 miles of country, for the most part new to Europeans. Six months later, two other foreigners set out in an opposite direction, and travelled overland from Teentsin to Moukden, the capital of Manchoo Tartary. They were struck by the manner in which this once Tartar country has been virtually converted into a Chinese province by the superior energy of the Chinese emigrants, and report that the Manchoos, even in this their native land, have lost their ground entirely in all parts of the country where anything is to be made by agriculture and commerce; and that those who remain, by adopting Chinese manners, customs, and *language*, have become, to all intents and purposes, Chinese, and have been absorbed into the predominant race. Later in the year, in November and December, an expedition through the two northern provinces of China, Pe-chih-le and Shan-se, was undertaken by Messrs. Richards and Slossin. Starting from the same point—Teentsin—they appear to have ascended the high plateaus to the north of Peking, and to have skirted the Mongolian steppes until they reached Shan-se. They travelled in this province as far as its capital Tai-yuen, and then, turning westward, re-entered Pe-chih-le, and visited Paou-king, the capital of the latter province, on their way back to Teentsin. The journey occupied the travellers 46 days, during which time they appear to have crossed the Great Wall four times, finding it in a state of decay that may be feared is typical of the country of which it is the chief monument, and they estimate the total length of their journey at 1560 English miles. The flourishing and populous condition of most of the country through which they passed accounts for the success of the new nothern port of Teentsin, the foreign trade of which, in the first year of its being opened, has reached the considerable sum of two millions sterling.

In the centre of China, four gentlemen—Messrs. Dickson, Thorburn, Beach, and Bonney—travelled, in the month of April, from Canton to Hankow, a distance of 756 miles, which they performed in 18 days; their journey differing from those above recited as being made entirely by water, with the exception of one day's land travel across the mountain-range that divides the province of Kwangtung from Hoo-nan. Following the course of the north river in the first-named province, and the Seang river in the latter, they thus traversed both those provinces from south to north, and were the first modern explorers of the great Tungting lake, by which they reached the Yang-tze and Hankow. In Chehkiang, Mr. Baker, having recently ascended the Tseentang river, and visited the celebrated green-tea districts of Nganhwuy, has again gone over ground previously travelled by Mr. Fortune, but to find in this instance that the previous prosperous condition of those important tea districts has disappeared before the rebel scourge, and that scenes of industry have been replaced by desolation and destruction.

In the south of China, the Rev. Dr. Legge was the first foreigner to ascend, in April of last year, the east river in the Kwangtung province

to a distance of about 300 miles; and the Rev. Mr. Irwin and companions have penetrated up the west river, in the same province, to a somewhat higher point than that reached by the expedition under Captain McCleverty in the spring of 1859, for a description of which we are indebted to our associate Lieutenant Brine. The opening of Formosa to foreign trade gives promise also of our shortly obtaining further information from that island, which is interesting not only from its commercial productions, but also from the presence of aboriginal tribes in its centre and eastern coast, of which little is as yet known.

It is satisfactory to hear from all these travellers that no serious obstacles were placed in their way either by the Chinese authorities or the people; and that, while inconvenienced at times by the not unnatural curiosity of the latter, when anxious to gaze on foreigners for the first time, they received from them, in most cases, friendly welcome and assistance. Our treaty-right to enter the country having thus obtained an effectual recognition, it will be seen that China is now thrown open to the researches of the traveller, subject, however, to the difficulties arising out of the deplorable disorders which are at present rife in so many of its provinces. Different parties of rebels or robbers, all acting independently of each other, were met by Colonel Sarel's party in Sze-chuen, by Mr. Morrison in Shantung, by Mr. Baker in Chehkeang, and by Mr. Irwin in Kwangtung; while Dr. Dickson's party, on the other hand, travelled from Canton to Hankow—or from the south to the centre of China—without falling in with any of these destructive hordes; and Messrs. Richards and Slossin traversed the provinces of Shan-se and Pe-chih-le under similar favorable circumstances.

Measurement of a Peak in the Karakorum range, second in height to Mount Everest.—The Journal of the Asiatic Society of Bengal (xxix, p. 20), contains a statement respecting the survey of Kashmir, by Capt. Montgomerie of the Topographical Survey of India. After referring to the fact that the peak Nanga Parbut, having a height of 26,629 feet, had been regarded as king of the Northern Himalayas, as Mount Everest, having a height of 29,002 feet, is king of the southern Himalayas, —the writer, Maj. Thuillier, Dep. Surveyor General, announces the measurement of a new snowy peak, termed for the present K. 2, on the Karakorum range, which is probably the second highest known mountain in the world. He writes as follows:

"The party under Captain Montgomerie is now engaged in Thibet. The country is exceedingly difficult and the strength of the party much diminished. In the progress of the survey advantage has been taken of the opportunity to extend accurate geographical knowledge by fixing numerous peaks in the Karakorum and Mustag ranges. One of those already determined on the Karakorum range, along which runs the boundary between Ladakh and Yarkund, one hundred and fifty-eight miles N.E. of Srinagar, is 28,278 feet high (provisionally settled only, being liable to a small correction when the levelling operations from

the sea level at Karachi, now in progress, are completed). None of the peaks in the neighborhood of K. 2 come nearly up to it though there is one fine group about sixteen miles away that is generally a little over twenty-six thousand. This is probably the second highest mountain in the world, as it exceeds Kanchinginga by 122 feet, but is lower than Mount Everest by 724 feet, as measured by the Surveyor General in 1847.*

It is expected that Captain Montgomerie will be able to fix points up to 36° 30′ N. latitude, but it is doubtful whether he will be able to get in all the Topography quite as far as that, in consequence of the wild and Yághi state of some of the people."

A sketch showing the position of this mountain, and its environs, is given in Petermann's Mittheilungen, 1861, p. i.

FIJI ISLANDS.—The British Government have lately had under consideration a project for making the Fiji Islands a dependency of the British Crown. An expedition was sent to the islands under Col. Smythe, R.A., to investigate the circumstances under which the proposal was made. Dr. Seemann, a member of the Commission, has given the following Report to the Royal Geographical Society:

* * * "The islands are now visited by traders from many nations; and the object of their inhabitants in appealing to England, was to extricate themselves from political embarrassments which were becoming fastened upon them.

The report of the Commission was favorable to the bonâ fide nature of the proposal and also to the value of the islands as fertile, healthy, and convenient stopping places for the traffic to Australia by way of Panama. The question of the acceptance of their sovereignty was under the consideration of the British Government.

The Fiji group owe their origin to a volcanic upraising and to the growth of corals; the islands are usually hilly, and present an unbroken mass of trees on their southern side, while their northern slopes are grassy and watered by streams descending from the central highlands, whose ridges condense the vapor of the trade-winds.

A great variety of vegetation is found in the islands: its predominant appearance is tropical. The mangrove-swamps are confined to the deltas of the rivers, and the islands are singularly exempt from malignant fever.

Their fertility may be estimated from the fact that, though partially and imperfectly cultivated, they support a population of 200,000, and supply provisions to foreign vessels and yield an immense export of cocoa-nut-oil, obtained by a wasteful process. Their fertility appears still more remarkable on considering the variety of their vegetable productions useful to man. Sugar, coffee, tamarinds, and tobacco are cultivated with success; so are four oil-yielding and five starch-yielding plants; four different spices; twelve edible roots; eleven potherbs; thirty-six edible fruits; and a vast number of medicinal, fibrous, scent-yielding, and ornamental plants, besides a long list of first-class timber-trees. It was the abundance of sandal-wood that first attracted Europeans to their shores.

* See Geog. Not., V, this Jour., [2], xxvii, 62.

They promise an excellent field for the best qualities of cotton; the undulating ground, the neighborhood of the sea, and the absence of frost being cogent reasons in favor of its growth: the inhabitants are also beginning to work for wages. Experiments in raising cotton have already been tried with remarkable success, both by Dr. Seemann and by others.

Dr. Seemann bears witness to the laudable influence of the Wesleyan missionaries over the islanders, who recently were savage cannibals. He considers the religion which Christianity is beginning to supplant, as well worthy of philosophical study. Their belief is in a Supreme Deity, and in future rewards and punishments. They worship their ancestors. The chiefs are a taller, better developed, and in every respect a more able caste of men than the rest; it follows from this that mere height of stature in a stranger is an important claim upon the consideration of the islanders."

ART. XXXII.—*Contributions from the Sheffield Laboratory of Yale College.*—IV. *Observations on Caesium and Rubidium;* by OSCAR D. ALLEN, Ph.B., Assistant in the Sheffield Laboratory.

THE discovery of the presence of the new elements rubidium and caesium in several varieties of European lepidolite, made it a subject of interesting inquiry to ascertain whether American lepidolite would not also serve as a source for these rare metals.

A preliminary experiment made last autumn by Mr. John M. Blake and myself, having shown that the lepidolite from Hebron in Maine contains these alkalies in comparative abundance, I was led to visit that locality, and there obtained the material which served for the following investigation.

Lepidolite occurs at Hebron in large quantity, in a coarsely crystalline granite, associated with red and green tourmaline and albite. It has a granular, and at the same time foliated, crystalline structure, a pale rose to violet color, and very closely resembles the lepidolite of Penig in Saxony, and like that is also associated with the rare species amblygonite.* This locality is only eight miles from that in Paris, which has long been known to mineralogists.

Preparation of the salts of Caesium and Rubidium from the Hebron Lepidolite.—The process used for decomposing this mineral was based upon that employed by Prof. J. Lawrence Smith for the determination of alkalies in silicates. Ten parts of the pulverized lepidolite were first mixed with forty parts of coarsely powdered quicklime; a mixture of enough water to slake the quicklime, with hydrochloric acid sufficient to form from six to

* This Journal, [2], xxxiv, 243.

seven parts of chlorid of calcium was next made ready; the two mixtures were then united, and stirred vigorously during the process of slaking, thus intimately blending the mineral with suitable proportions of dry hydrate of lime, and chlorid of calcium.

It was found by experiment that practically as good results were obtained when the lepidolite was powdered sufficiently fine to pass a sieve of 20 holes to the linear inch, as when it was more finely pulverized, the fact being that the foliated structure of the mineral exposes a large surface to the decomposing agency of the lime mixture.

The mixture was heated to redness for six to eight hours in hessian crucibles. Care was taken to avoid a heat much above redness, as otherwise alkali-chlorids volatilize in dense clouds, and the mass fusing, is absorbed to a considerable extent into the crucible and lost. The long duration of the ignition was a matter of convenience, due to the character of the furnace employed, and probably not necessary to the decomposition of the mineral.

The agglomerated product obtained from the ignition of this mixture was detached from the crucibles and boiled with water a quarter to half an hour, and leached till all but a trace of the chlorids was removed. The solution thus procured, containing chlorid of calcium and the chlorids of the alkali-metals, was evaporated till crystals began to form, then sulphuric acid was added as long as sulphate of lime separated, taking care to avoid an excess, and the whole mass was evaporated to dryness, and strongly heated to expel free hydrochloric acid. The residue was treated with water, and the small quantity of sulphate of lime which went into solution, was precipitated by carbonate of ammonia, the filtered solution was again evaporated to dryness and ignited.

Ten and a half kilogrammes of lepidolite treated in this way afforded 2169 grammes of salts consisting of chlorids, with a small admixture of sulphates, of sodium, lithium, potassium, rubidium and caesium. This quantity of salts subjected to Bunsen's process of fractional precipitation with bichlorid of platinum, furnished 132 grammes of the platinchlorids of caesium and rubidium in which no potassium could be detected with the spectroscope. The platinchlorids were very gently heated in a current of hydrogen gas until complete reduction of the platinum took place, and the chlorids were then extracted with water.

The per-centages of caesium and rubidium obtained from the mineral by this process were calculated from the amount of chlorine contained in these mixed chlorids.

0·5825 grm. dissolved in water and precipitated with nitrate of silver gave 0·5835 grm. of chlorid of silver, which represents 0·1439 grm. of chlorine.

These numbers furnish the following equations:

$$(1) \quad Rb+Cs=0{\cdot}5825-0{\cdot}1439$$

$$(2) \quad \frac{Rb}{85{\cdot}36^*}+\frac{Cs}{123{\cdot}35^*}=\frac{0{\cdot}1439}{35{\cdot}5}$$

which give Cs=0·3002 and Rb=0·1384. According to these proportions the 132 grammes of platinchlorids contained 31·1969 grammes of caesium, 14·3826 grammes of rubidium, which numbers respectively correspond to 0·3 per cent and 0·14 per cent of the mineral employed.

It appears therefore that it is practicable to extract almost one half per cent of the two metals from the Hebron lepidolite, even when operating on a large scale, and in a somewhat crude manner. In separating the platinchlorids of caesium and rubidium from the platinchlorid of potassium, a not inconsiderable amount of these metals went into solution with the potassium salt, thus materially diminishing the quantity obtained. Much the larger proportion of this loss was rubidium, due to the greater solubility of its platinchlorid. On comparing these results with Cooper's analyses† of the Rozena lepidolite, it appears that although not quite so rich in rubidium, the Hebron mineral is remarkably rich in caesium. The lepidolite from Rozena and Zinnwald contain, according to the published analyses, only an unweighable trace of caesium, while that from Hebron contains more than three-tenths of one per cent.

Experiments in separating Caesium and Rubidium.—The process described by Bunsen for separating the new alkalies appeared to be so troublesome, requiring for the preparation of pure rubidium salts 20 to 30 extractions of the carbonates with boiling absolute alcohol (*Ann. Chem. u. Phar.*, cxxii, 353) that I have made various attempts to discover a simpler method.

In the first place a trial was made with the picrates of the new metals. To a concentrated solution of their mixed chlorids an alcoholic solution of picric acid was added. The liquid immediately filled with fine acicular crystals. These were rinsed with water and successively recrystallized from fresh portions of water eleven times. Portions of the 1st, 2d, 3d, 4th, 7th, and 11th crops of crystals were separately examined in the spectroscope, the picrates being converted into chlorids for this purpose, by treatment with aqua regia. No difference being observable between the spectra of the various crops, no further experiments were made in this direction. It may be here remarked that the mixed picrates crystallize with great facility in needles an inch in length, and perfectly resemble the corresponding potassium salt.

* Combining proportions of caesium and rubidium determined by Bunsen.—*Pogg. Ann.*, cxiii, 339.

† *Jour. prakt. Chem.*, lxxxv, 125.

A second series of trials was made with the platinbromids of potassium, rubidium and caesium. The platinbromid of potassium is known to be readily soluble in water. The platinbromids of caesium and rubidium readily separate from dilute solutions of these three metals, but carry down potassium with them. For the removal of the latter metal from the new alkalies the platinbromids appear to have no advantage over the platinchlorids, while they are equally inadequate to the separation of caesium and rubidium from each other. In external characters the three platinbromids closely resemble each other.

Finally, recourse was had to the bitartrates, and with satisfactory results. Carbonates of caesium and rubidium were first prepared from the chlorids by converting them into sulphates, separating the sulphuric acid with caustic baryta, and removing the excess of baryta by carbonic acid. To the alkaline solution thus obtained, twice as much tartaric acid was added as was necessary to neutralize it. This solution was concentrated till it was nearly saturated at 100° C. The crystals which deposited on cooling when examined by the spectroscope, showed the rubidium lines more intensely than did the original mixture, while the caesium lines were much fainter. This product was dissolved and recrystallized from hot saturated solutions three times. The caesium reaction in these successive crops diminished until in the fourth it disappeared, leaving the rubidium spectrum in entire purity.

In order to ascertain whether the more soluble bitartrate of caesium could be purified from rubidium by fractional crystallization, the solution from which the first crystals had been removed was concentrated to nearly one-half its original volume, when by cooling, a very small quantity of salts of the two alkalies was deposited. This operation was repeated three times, when a portion of the solution evaporated to dryness, and examined by the spectroscope gave only the lines belonging to caesium. The several intermediate products containing both alkalies were then united and another portion of each salt separated from them in the same manner. By repeating this process of fractional crystallization four times with about 40 grammes of the mixed salts, 23·77 grammes of bitartrate of caesium, and 12·511 grammes of bitartrate of rubidium were obtained, while 3·74 grammes remained unseparated. It was found that the caesium salt thus obtained, although exhibiting no impurity when tested by the spectroscope directly, i. e. after conversion by ignition into carbonate, was still mixed with a trace of rubidium, as on converting it into chlorid, a faint line characteristic of the latter metal was perceptible. The separation of two or three more small crops of crystals sufficed to render the residual solution perfectly free from any admixture that could be detected by a

spectroscope of ordinary power.* The rubidium salt was also more carefully tested in the same manner, but was found to be entirely pure.

The process above described thus furnishes a simple and easy method of separating in a perfectly pure state a large share (in these trials about 90 per cent) of a mixture of the two alkalies. It requires no great expenditure of time, since the solutions employed can be concentrated at high temperatures, and on cooling immediately deposit well formed crystals.

Composition and solubility of the Bitartrates of Caesium and Rubidium.—Bitartrate of rubidium crystallizes from hot solutions in colorless transparent flattened prisms, which are often half an inch or more in length, even when formed rapidly from small quantities of solution. They remain unaltered in the air and also are unchanged at a temperature of 100° C. The pulverized salt dried at 100° C. was burned with chromate of lead in the usual manner.

I. 0·4681 grm. gave { 0·0902 grm. water, and / 0·354 " carbonic acid.

To determine the base, the salt was heated to a temperature a little below redness, the resulting carbonate extracted with water from a small residue of carbon which could not be burned away without volatilizing rubidium. The carbonate was then converted into chlorid, fused and weighed without exposure to the air.

II. 1·3772 grm. gave 0·7149 grm. chlorid of rubidium.

In the following statement these results are reduced to per cents, and compared with the calculated composition of bitartrate of rubidium as expressed by the formula

$$\left.\begin{matrix} C_8\ H_4\ O_8 \\ H\quad\ Rb \end{matrix}\right\} O_4$$

	Calculated.		Found.	
			I.	II.
C_8	48·00	20·48	20·62	....
H_5	5·00	2·13	2·17	....
O_{11}	88·00	37·55	....	....
RbO	93·36	39·84	....	40·09
	234·36	100·00		

The solubility of this salt in hot and cold water was determined by evaporating on the water-bath, solutions saturated at the given temperatures and weighing the residues.

I. 11·9254 grammes of solution saturated at the boiling point, gave a residue of 1·2555 grammes.

* The instrument used was a modification of Bunsen and Kirchhoff's spectroscope, devised by Prof. J. P. Cooke, and manufactured by Messrs. Alvan Clark & Sons of Cambridgeport.

One part of the salt accordingly requires 8·5 parts of boiling water for solution.

II. 17·535 grms. of solution saturated at 25° C. gave a residue of 0·205 grm.

III. 16·094 grms. of solution saturated at 25° C. gave a residue of 0·188 grm.

One part of the salt thus required respectively 84·53, and 84·6 parts of water at 25° C. for solution.

The *bitartrate of caesium* forms crystals closely resembling the rubidium salt, but in my experiments they were usually of smaller size.

The salt obtained by concentrating the solution from which all the rubidium had been separated, was to all appearance pure. It was recrystallized, and after drying at 100° C., at which temperature it suffered no loss of weight, was analyzed in the same manner as the bitartrate of rubidium.

I. 0·4718 grm. gave { 0·0786 grm. water, and / 0·294 " carbonic acid.

II. 0·5966 grm. gave { 0·101 grm. water, and / 0·372 " carbonic acid.

III. 1·3086 grm. gave 0·7708 grm. chlorid of caesium.

Assuming the combining proportion of caesium to be 123·35, as determined by Bunsen, the following statement exhibits the composition of the salt, according to the formula,

$$\left.\begin{matrix} C_8\ H_4\ O_8 \\ H\ \ \ Cs \end{matrix}\right\} O_4$$

	Calculated.		Found.		
			I.	II.	III.
C_8	48·00	17·62	16·99	17·02	....
H_5	5·00	1·83	1·85	1·88	....
O_{11}	88·00	32·31	....	....	....
CsO	231·35	48·24	....	....	48·70
	272·35	100·00			

The discrepancy between the composition as calculated and found is perhaps due to a slight admixture of the neutral tartrate which might possibly have been present, owing to the use of insufficient tartaric acid.

The solubility of bitartrate of caesium was determined for the same temperature and by the same methods as were employed in case of the rubidium salt.

I. 2·998 grms. of solution saturated at the boiling point gave a residue of 1·483 grms.

One part of the salt requires 1·02 part of boiling water for solution.

II. 11·931 grms. of solution saturated at 25° C. gave a residue of 1·054 grms.

III. 8·7625 grms. of saturated solution at 25° C. gave a residue of 0·7727 grm.

One part of the salt accordingly requires 10·32 parts of water at 25° C. for solution.

The fact that bitartrate of rubidium requires about eight times as much water for solution as bitartrate of caesium, explains the facility with which these salts can be separated from each other by crystallization.

In these experiments I have received the advice and assistance of Profs. Johnson and Brush, for which I here take pleasure in expressing my most grateful acknowledgments.

New Haven, Aug. 12th, 1862.

Note.—Since the above was written I have recovered from the mother-liquors and washings of the 132 grms. platinchlorids of caesium and rubidium first obtained, an additional quantity of potash-free platinchlorids (chiefly of rubidium) amounting to 40 grms., making the total yield 172 grms. from 10½ kilogrammes of lepidolite. Most of this remained in solution from the use of insufficient bichlorid of platinum in some of the precipitations. The content of rubidium in the Hebron lepidolite thus appears to be not less than in that from Rozena. O. D. A.

ART. XXXIII.—*Abstract of an investigation of the solar diurnal variation and of the annual inequality of the Horizontal Component of the Magnetic Force, from observations made at the Girard College Observatory, between* 1840 *and* 1845; by A. D. BACHE, LL.D., F.R.S., Sup't U. S. Coast Survey.

PART V.—*Of the discussion of Magnetic and Meteorological Observations made at Girard College, Philadelphia.*

THE previous discussion (Part IV) (p. 261) of the observations of the horizontal force, furnishes the materials from which the investigation of the diurnal and annual variation of the horizontal force is made. The monthly normal values for each hour of observation were corrected for temperature and for irregularity in the progressive change, and freed from the influence of the larger disturbances. The monthly normals of the five years' series are tabulated according to the months of the year and hour of the day and the method of interpolation for omissions of observations and the like, explained in Part II, has been in general followed. The irregularities of the first month of observation were, however, such as to render it expedient to omit these results and to begin the year with July.

The several values of the monthly normals are taken from Table VII, Part IV, the correction shown in the remarks to Table V, Part IV, to be necessary, having been applied.

It will be recollected that the observations were made 21½ minutes after the hour of mean local time, counting from mid-

night to midnight. Increase of scale readings correspond to decrease of horizontal force. One scale division was equivalent to 365 ten millionths of the force, or, in absolute measure to 1524 ten millionths, the mean horizontal force being, in absolute measure 4·176. Proper weights, according to the number of observations were given to the results for the even and odd hours.

The tables given in the memoir contain the hourly normals for each month of the five years, and for the mean, reckoned in scale divisions, and reduced to the standard temperature of 63° Fahrenheit and corrected for irregularities in the progressive change. The numbers there contain the regular progressive and secular changes.

From these detailed tables are formed the following:—

TABLE No. I.—*Recapitulation of the hourly normals of the horizontal maynetic force, expressed in scale divisions. Increase of scale readings correspond to decrease of force. The observations were made 21½ minutes after the hours stated at the heads of the several columns.*

1840-45.	0h	1	2	3	4	5	6	7	8	9	10	11h	+21½m
July,	681	679	677	675	673	668	664	673	686	692	694	690	
Aug.	698	699	699	698	699	695	693	702	714	724	726	718	
Sept.	720	718	720	718	714	713	711	721	735	744	749	746	
Oct.	735	731	731	727	725	728	729	734	739	746	751	750	
Nov.	739	738	736	734	733	730	728	732	737	743	746	751	
Dec.	772	767	766	764	761	759	756	758	761	766	775	783	
Jan.	794	792	792	790	788	787	786	784	786	795	802	808	
Feb.	800	798	796	796	795	793	791	793	795	800	808	810	
March,	803	802	801	800	799	797	795	799	804	812	817	822	
April,	824	823	823	820	818	817	817	820	829	841	849	851	
May.	834	833	830	829	829	826	824	829	838	846	847	843	
June,	858	858	858	858	855	852	849	855	861	867	869	866	
Year,	771·5	769·8	769·1	767·4	765·7	763·7	761·9	766·7	773·7	781·3	786·1	786·5	
Summer,	769·2	768·3	767·8	766·3	764·7	761·8	759·7	766·7	777·2	785·7	789·0	785·7	
Winter,	773·8	771·3	770·3	768·5	766·8	765·7	764·2	766·7	770·3	777·0	783·2	787·3	

1840-45.	12h (noon)	13	14	15	16	17	18	19	20	12	22	23h	+21½m
July,	683	672	663	660	659	666	675	677	679	681	682	683	
Aug.	708	698	689	688	692	696	701	703	704	703	704	702	
Sept.	736	726	720	718	719	723	724	725	723	725	722	722	
Oct.	751	747	743	740	739	739	738	739	740	739	739	738	
Nov.	750	746	740	738	737	739	736	736	737	739	741	740	
Dec.	785	778	773	768	764	765	767	768	771	772	772	771	
Jan.	808	801	796	790	787	790	793	794	793	794	794	796	
Feb.	813	808	804	800	801	800	801	804	806	802	800	800	
March,	819	814	806	801	804	807	810	808	804	803	805	804	
April,	845	839	827	824	822	822	827	827	830	830	828	827	
May,	837	830	825	824	823	825	831	832	835	836	835	832	
June,	860	855	848	847	847	851	856	858	859	858	859	859	
Year,	782·5	776·2	769·5	766·5	766·2	768·6	771·6	772·6	773·4	773·5	773·4	772·8	
Summer,	778·2	770·0	762·0	760·2	760·3	763·8	769·0	770·3	771·7	772·2	771·7	770·8	
Winter,	787·7	782·3	777·0	772·8	772·0	773·3	774·2	774·8	775·2	774·8	775·2	774·8	

The following table contains the mean values of the normals for each month and season, reckoning as the summer season, the half year from April to September inclusive, and as the winter, the months from October to March inclusive.

TABLE No. II.

1840-44.	Normal.
July,	676·3
Aug.	702·2
Sept.	724·6
Oct.	738·2
Nov.	738·5
Dec.	768·4

1844-45.	Normal
Jan.	793·3
Feb.	800·6
March,	805·7
April,	828·3
May,	832·2
June,	856·8

1840-45.	Normal.
Year,	772·1
Summer,	770·1
Winter,	774·1

To obtain the regular solar diurnal variation for each month and season of the year, we subtract the numbers in table I. from their respective monthly and season and yearly mean values given in table II. After converting these numbers into parts of the absolute horizontal force, table No. III. of the memoir shows the results, the significant numbers being expressed in units of the sixth place of decimals and the sign + indicating a value greater than the mean, and the sign − one less than the mean. Three decimals 0·000 are placed at the side of the table. This table is omitted in the present abstract.

Table No. IV. shows the results obtained in table III, converted into absolute measure by multiplying by 4·176 the absolute horizontal force. Two places of decimals 0·00 are placed at the side of the table and are to be understood as preceding each number.

The annual inequality in the daily variation of horizontal force as derived from table No. IV, is shown in diagram A. The annual mean shows a maximum value about 6 A. M., a minimum about 11 A. M., a secondary maximum about 3½ P. M. and a secondary minimum about 9 P. M. The maximum at 6 A. M. is stationary throughout the year. The morning minimum is lower during the summer when the sun's declination is north, and the afternoon maximum is higher, thus increasing the daily range. The converse takes place in winter. The average summer range is 0·0046, and the average winter range 0·0025. The average range between the morning maximum and the morning minimum in summer is 0·0045 and in winter 0·0036.

The half yearly change is better represented in the annexed diagram (B) derived from (A) by straightening out the annual curve and using it as an axis of abscissæ, upon which to lay off the differences between the values of the same hours for the year, and for the summer and winter. The comparison of this diagram with the corresponding one in Part II. for the annual change in the diurnal variation of the declination is of considerable interest.

At 6 A. M. there is scarcely any change during the year. The maximum change occurs about 9 A. M., the range being about

TABLE No. IV.

0·00	1840-45.	0ʰ	1	2	3	4	5	6	7	8	9	10	11ʰ	+21½ᵐ
	July,	-071	-041	-010	+020	+050	+127	+188	+050	-147	-239	-270	-208	
	Aug.	+064	+048	+048	+064	+048	+109	+140	+003	-180	-332	-362	-242	
	Sept.	+070	+101	+070	+171	+162	+177	+201	+055	-159	-296	-372	-326	
	Oct.	+048	+109	+109	+100	+201	+155	+140	+064	-012	-119	-195	-180	
	Nov.	-008	+008	+038	+068	+083	+129	+160	+095	+022	-068	-114	-190	
	Dec.	-055	+021	+037	+067	+113	+143	+189	+159	+113	+037	-101	-223	
	Jan.	-010	+020	+020	+050	+081	+096	+111	+141	+111	-025	-132	-224	
	Feb.	+009	+040	+061	+070	+085	+116	+146	+116	+085	+009	-113	-143	
	March,	+041	+056	+071	+086	+102	+132	+163	+102	+025	-096	-172	-248	
	April,	+066	+081	+081	+127	+157	+172	+172	+127	-010	-193	-315	-346	
	May,	-027	-012	+033	+048	+048	+094	+125	+048	-088	-210	-226	-165	
	June,	-018	-018	-018	-018	+027	+073	+119	+027	-064	-155	-186	-140	
	Year,	+009	+034	+045	+071	+096	+127	+155	+083	-025	-141	-213	-220	
	Summer,	+014	+026	+034	+057	+082	+125	+157	+053	-108	-238	-289	-238	
	Winter,	+004	+042	+056	+086	+111	+129	+152	+114	-058	-044	-138	-201	

0·00	1840-45.	12ʰ (noon)	13	14	15	16	17	18	19	20	21	22	23ʰ	+21½ᵐ
	July,	-102	+065	+203	+248	+263	+157	+020	-010	-041	-071	-102	-102	
	Aug.	-088	+064	+201	+216	+155	+094	+018	-012	-027	-012	-027	+003	
	Sept.	-174	-021	+070	+101	+085	+024	+009	-006	+024	-006	+040	+040	
	Oct.	-195	-134	-073	-027	-012	-012	+003	-012	-027	-012	-012	+003	
	Nov.	-175	-114	-022	+008	+022	-008	+038	+038	+022	-008	-038	-022	
	Dec.	-253	-146	-070	+006	+067	+052	+021	+006	-040	-055	-055	-040	
	Jan.	-224	-132	-041	+050	+096	+050	+005	-010	+005	-010	-010	-041	
	Feb.	-189	-113	-052	+009	-006	+009	-006	-052	-082	-021	+009	+009	
	March,	-203	-127	-005	+071	+025	-020	-065	-037	+025	+041	+010	+025	
	April,	-254	-163	+020	+065	+096	+096	+020	+020	-025	-025	+005	+020	
	May,	-073	+033	+109	+125	+140	+109	+018	+003	-043	-058	-043	+003	
	June,	-048	+027	+134	+149	+149	+088	+012	-018	-033	-018	-033	-033	
	Year,	-165	-063	+040	+085	+090	+053	+008	-008	-020	-021	-021	-011	
	Summer,	-123	+001	+123	+151	+148	+095	+015	-004	-024	-032	-027	-012	
	Winter,	-206	-128	-044	+020	+032	+012	-000	-011	-016	-011	-016	-010	

0·00194 in absolute measure. About 11½ A. M. there is an epoch of no variation. At 2 P. M. a second maximum, about 0·00167 is reached. At 7½ and 11 P. M. points of no change are reached.

To find the turning epochs of the annual variation, the monthly values for the hours of 9 A. M. and 2 P. M. when best developed were taken from table No. IV. and again compared with the annual mean as in the following table.

TABLE No. V.—*Annual variation at the hours of* 9 A. M. *and* 2 P. M. *compared with the annual mean.*

	9 A. M. 0·00	Diff. 0·00	2 P. M. 0·00	Diff. 0·00	Mean differ. 0·00
January,	-025	+116	-041	-081	+099
February,	+009	+150	-052	-092	+121
March,	-096	+045	-005	-045	+045
April,	-193	-052	+020	-020	-016
May,	-210	-069	+109	+069	-069
June,	-155	-014	+134	+094	-054
July,	-239	-098	+203	+163	-130
August,	-332	-191	+201	+161	-176
September,	-296	-155	+070	+030	-092
October,	-119	+022	-073	-113	+046
November,	-068	+073	-022	-062	+068
December,	+037	+178	-070	-110	+144
Mean,	-141		+040		

This table shows by the change of sign and progress of values, that the epoch of change occurs some time after the equinoxes, and that the maximum of variation is reached about the time of the solstices, a result which corresponds closely with that derived from the discussion of declination in Part II. Representing the average of the results for each half year by the usual analytical formula, we find that the change takes place about twenty-two days after the equinoxes which is about twelve days later than we found for the declination.

To obtain the best result from observations, the values of table No. I were thrown into the usual analytical form, equations for each month, for the half year, and for the year's results having been obtained. The analytical results for a determinate hour of any month differ but slightly from the observed results. For example the differences for August between the computed and observed results, differ in no case more than three scale divisions and generally range between 0 and 2. Diagrams (C) and (D) represent these results, the dots corresponding to the observed quantities and the curves to the results of analysis. The results for the summer months are given in diagram C, and those for the winter in diagram (D). The comparison of the two diagrams shows the much greater range of the variation of horizontal force when the sun is north of the equator, as was also found from the discussion of the magnetic declination.

Diagram (E) gives the curves of regular solar diurnal variation of the horizontal force for the summer, the winter, and for the whole year.

Table VIII, contains the computed values of the time and amount of the morning maximum and minimum and of the afternoon maximum. The values for the secondary afternoon minimum are taken from the diagrams. The time of the A. M. maximum and minimum is within the nearest eighth minute, that of the P. M. maximum within the nearest tenth minute, that for the P. M. secondary minimum within the nearest hour. The change of force is expressed in scale divisions.

The extreme variation in the epoch of the A. M. maximum is $2^h\,15^m$. The variations for the A. M. minimum is $1^h\,55^m$, for the P. M. maximum it is $2^h\,30^m$, and for the secondary afternoon minimum between three and four hours. In all cases the earlier hours occur in the summer season. Table IX shows the diurnal range, expressed in scale divisions, parts of the horizontal force and in absolute measure. In the second column the range between the A. M. maximum and minimum is given; in the third column that between the A. M. minimum and the P. M. maximum. These two amplitudes for A. M. and for A. M. and P. M., are further illustrated in diagram (F), which shows the curve to be double crested with maxima near the time of the equinoxes and the greater of these near the autumnal equinox.

TABLE No. VIII.

	Morning maximum.		Morning minimum.		Afternoon max.		Secondary Afternoon min.		Interval A. M. min. to P. M. max.
	h. m.	*d.*	*h. m.*	*d.*	*h. m.*	*d.*	*h.*	*d.*	*h. m.*
January,	7 10	− 9·2	11 50	+15·7	4 10	− 5·3	11	+2	4 20
February,	7 15	− 9·6	11 40	+12·7	4 00	− 0·9	7	+2	4 20
March,	6 15	− 9·2	11 30	+16·4	3 20	− 2·3	6	+3	3 50
April,	6 00	−12·3	11 20	+22·5	3 55	− 6·6	9	+3	4 35
May,	5 50	− 7·9	10 25	+15·5	3 10	− 9·8	9	+4	4 45
June,	5 50	− 6·3	10 30	+12·5	3 20	−10·4	8	+3	4 50
July,	5 35	− 9·9	10 30	+19·3	3 25	−17·5	9	+6	4 55
August,	5 55	− 8·5	10 10	+24·8	2 45	−14·2	9	+3	4 35
September,	5 35	−14·9	10 20	+25·9	3 05	− 6·7	7	−1	4 45
October,	5 00	−12·6	11 15	+13·7	5 10	− 0·1	9	+2	5 55
November,	6 00	− 9·8	11 25	+11·0	5 15	− 3·0	11	+0	5 50
December,	7 05	−12·1	12 05	+16·1	4 35	− 5·1	10	+4	4 30
Summer,	5 50	− 9·8	10 30	+19·6	3 25	−10·5	20½	+3	4 55
Winter,	6 15	− 9·4	11 45	+13·9	4 10	− 2·2	21	+2	4 25
Year,	5 55	− 9·6	11 00	+15·6	3 35	− 6·0	20¾	+2·5	4 35

TABLE IX.—*Amplitude of the diurnal variation of the horizontal force.*

	For A. M.	For A. M. & P. M.	For A. M.	For A. M. & P. M.	For A. M.	For A. M. & P. M.
	d.	*d.*				
Jan.,	24·9	21·0	0·00091	0·00077	0·0038	0·0032
Feb.,	22·3	13·6	081	050	34	21
March,	25·6	18·7	093	068	39	29
April,	34·8	29·1	127	106	53	45
May,	23·4	25·3	085	092	36	38
June,	18·8	22·9	069	084	29	35
July,	29 2	36·8	106	134	45	56
August,	33.3	39·0	122	142	51	59
Sept.,	40·8	32·6	149	119	62	50
Oct.,	26·3	13·6	096	050	40	21
Nov.,	20·8	14 0	076	051	32	21
Dec.,	28·2	21·2	0·00103	077	0·0043	0·0032
Summer,	29·4	30·1	0 00107	0 00110	0 0045	0·0046
Winter,	23·3	16·1	0·00085	0·00059	0·0036	0·0025
Year,	25·2	21·6	0·00092	0·00079	0·0038	0·0033
	In scale divisions.		In parts of the hor. force.		In absol. meas.	

The next table (X) contains the epochs when the mean horizontal force is reached in each day, as computed by the preceding formulæ. The diurnal curves intersect the axis of abscissæ four times, of which the table contains only the A. M. and first P. M. intersection, those later in the afternoon and near midnight occur in summer, winter and the whole year at 7 P. M., 5¾ P. M. and 6½ P. M. respectively, and at 11¼ P. M., 12 P. M., 11¾ P. M. respectively.

The above times are generally correct within 2 minutes (according to the formulæ). The morning hour of average daily horizontal force is less variable in the course of a year than the afternoon hour.

Diagram (G) exhibits the changes in the horizontal force in absolute measure from the monthly normal value for each hour of

TABLE X.—*Principal epochs of mean horizontal force.*

	A. M.	P. M.
January,	9h 20m	2h 36m
February,	9 23	2 58
March,	8 42	2 28
April,	8 14	2 19
May,	7 44	0 59
June,	7 47	0 48
July,	7 57	0 53
August,	7 28	0 44
September,	7 42	1 29
October,	8 08	5 00
November,	8 40	3 28
December,	9 34	3 03
Summer,	7 45	1 12
Winter,	9 00	3 07
Year,	8 14	1 54

the day and for each month of the year. The three variables are the hour of the day, the month of the year, and the difference of the horizontal force from the normal. The contour lines of the magnetic surface differ 0·0005 of horizontal force in absolute measure. Full lines indicate greater value, lines of dashes less value than the mean; dotted lines represent the normal value.

Annual variation of the horizontal force.—For the discussion of the annual variation we make use of monthly normal readings of the horizontal force as given in table No. II. If m equals the monthly effect of the total progressive change, we obtain from the twelve equations by the usual method the value $m = +15{\cdot}49$, and the correction for progressive change for July and June for instance becomes $+5{\cdot}5\,m$ and $-5{\cdot}5\,m$ respectively. The following table contains the monthly normals uncorrected and corrected for progressive change, also the differences from the mean of each month constituting the annual variation.

TABLE XII.

	Normals.	Corr. for prog. change.	Corrected normals.	Differences or annual variation.	0·000	0·00
July,	676·3	+85 2	761·5	+10·6	+39	+16
August,	702·2	+69·7	771·9	+ 0·2	+01	+00
September,	724 6	+54·2	778·8	- 6·7	-24	-10
October,	738·2	+38·7	776·9	- 4 8	-17	-07
November,	738·5	+23·2	761·7	(+10 4)	(+38)	(+16)
December,	768·4	+ 7·7	776·1	- 4·0	-15	-06
January,	793·3	- 7·7	785 6	-13·5	-49	-20
February,	800·6	-23 2	777 4	- 5 3	-19	-08
March,	805 7	-38·7	767 0	+ 5·1	+19	+08
April,	828·3	-54·2	774·1	- 2 0	- 7	-03
May,	832·2	-69 7	762·5	+ 9 6	+35	+15
June,	856 8	-85·2	771 6	+ 0·5	+02	+01
Mean,	772·1	0·0	772·1	In scale divisions.	In parts of the horizon force.	In absol. measure.

With the exception of the month of November, the values given above for the annual variation are tolerably regular in their progression, and considering the delicacy of the test applied to the observations in deducing the annual variation, this exceptional irregularity in the November value will not affect the general conclusion. We have as the general results a greater horizontal force in summer (April to August), and a smaller horizontal force in winter (from September to March) than the average annual value. The maximum occurs in July (at Toronto in June) and the minimum in January (at Toronto in December).

For Toronto we have the expression for the annual variation,

$$3{\cdot}531+0{\cdot}002 \sin(\theta+306^\circ)$$

For Philadelphia: (omitting the November value),

$$4{\cdot}176+0{\cdot}001 \sin(\theta+312^\circ),$$

the angle θ, in both equations counting from Jan. 15th.

The annnal range is 0·0021 (in absolute measure) the transition appears to take place about the time of the equinoxes or a short time before.

Table XIII contains the monthly normal values of the horizontal force in absolute measure obtained by adding (algebraically) 4·1760 to the values in the last column of table XII. These numbers, it will be observed, are corrected for secular change; if we apply the same we obtain the resulting monthly mean values of the horizontal force answering to the epoch, January 1843. The quantity A, mentioned in the explanatory remarks to table No. VII, is given in the last column of table No. XIII.

Table No. XIII.

	Normals. Corr. for secular change.	Monthly means affected with sec. ch.
July, - -	4·1776	4·1787
August, - -	4·1760	4·1769
September, -	4·1750	4·1757
October, - -	4·1753	4·1758
November, -	4·1776	4·1779
December, -	4·1754	4·1755
January, - -	4·1740	4·1739
February, - -	4·1752	4·1749
March, - -	4·1768	4·1763
April, - -	4·1757	4·1750
May, - -	4·1775	4·1766
June, - -	4·1761	4·1750
Mean, - -	4·1760	4·1760

ART. XXXIV.—*Abstract of the investigation of the influence of the Moon, on the Horizontal Magnetic Force, from observations made at the Girard College Observatory, in the years* 1840–'41–'42–'43–'44–'45; by A. D. BACHE, LL.D., F.R.S., Sup't U. S. Coast Survey.

PART VI.—*Of the discussion of Magnetic and Meteorological Observations made at Girard College, Philadelphia.*

THE method pursued in the investigation of the lunar effect on the horizontal force is, in general, the same as that explained in Part III of the discussion of the Girard College observations. The process may be briefly recapitulated as follows. Each observation for horizontal force after being corrected for the effect of difference from the standard temperature, and for progressive change, the disturbed readings being omitted (as fully explained in Part IV), was marked with its corresponding lunar hour. The observation nearest to the time of the moon's upper transit over the true meridian of the observatory was marked 0^h; that nearest to the lower transit 12^h; and the observations between for western and eastern hour angles of the moon, were marked with the proper lunar hour by interpolation. In the hourly series when thirteen observations were recorded in twelve lunar hours, that observation which is nearest midway between any two consecutive lunar hours was omitted. Each observation and reduced reading thus marked with its corresponding lunar hour was subtracted from the monthly normal belonging to its respective hour, and these differences were set down in tabular form, arranged according to lunar hours and keeping each monthly result separate for future combination.

The greatest difference possible is 33, the number of scale divisions which, according to the criterion, separates a disturbed from an undisturbed observation. For the formation of these differences which amount to more than 22000, the manuscript tables of the reduced record were used. These tables have already been referred to in the preceding paper, Part IV.

The units in which the differences are expressed, are scale divisions, one division being equal to 0·0000365 parts of the horizontal force, or to 0·000152 in absolute measure, the mean X being equal to 4·176 (in units of grains and feet).

The lunar effect on terrestrial magnetism being very small the process required for its elucidation is proportionally delicate. All the regular and irregular deviations arising from other sources must first be eliminated. In the method as indicated above, the magnetic disturbances (as far as they could be recognized); the diurnal and annual solar variation, as well as the

eleven (or ten) year inequality, and secular change, are all eliminated, leaving numbers fitted for the research of the lunar effect.

The readings taken in the month of June, 1840, have not been used in the discussion, nor in the two preceding parts, because of the imperfect manner in which the allowance for the progressive change could only be made at that time. For the lunar hour 21 in July, 1840, the number of differences is so small that the mean had necessarily to be reduced, and only one fourth of its amount was set down in the table. In January, February, and March, 1843, the observations were discontinued, excepting a single daily reading. Those months are therefore not included in the lunar discussion.

TABLE No. 8.—*Recapitulation of the annual means exhibiting the lunar diurnal variation from 22045 observations between 1840 and 1845, expressed in scale divisions.*

July to July.	U.Cul 0h	1	2	3	4	5	6	7	8	9	10	11h
1840-'41	−0·4	+0·5	+1·5	−0·3	−0·1	+0·3	−2·4	−1·3	−1·5	−0 2	+1·3	−0·1
1841-'42	+1·1	+2·0	+2 5	+0·9	+0·3	+1·1	+0·7	−1·1	−0·4	−1·3	−0·2	+1·0
1842-'43	+0 7	−0·9	−1·6	+2·9	+0·1	+1 6	+0·7	+1·9	−1·2	+0·7	−1 0	0 0
1843-'44	+0 9	+0·4	+0·8	+1·5	+0·9	−0·3	+0·4	+3 3	+0·1	−0 8	−1·2	−0·6
1844-'45	−0·9	+0 6	+0·5	+0·3	0·0	+0·6	+0·6	+0 9	+0·1	−0·3	0·0	+0·2
Mean,	+0·3	+0 5	+0·9	+1·1	+0·2	+0 7	0·0	+0 1	−0 6	−0·4	−0·2	+0·1

July to July	L. Cul. 12h	13	14	15	16	17	18	19	20	21	22	23h
1840-'41	+1·0	+0·8	+0 1	+0·4	−0·2	+0·6	−2·3	−1·3	+0·6	−2·1	+0 6	+1·2
1841-'42	+1·2	−0·1	−0·2	−1·5	−0·6	−2·4	−1·1	−0·2	−0·3	−0·3	−1·0	+1 4
1842-'43	+0·1	+0·1	+1·4	−0·6	+0·8	−0·9	−1·9	+0 1	−0·3	−0·8	+0·9	0·0
1843-'44	+0·3	−0·2	+0 2	+0·3	+1·3	−0·6	−0·9	−0·7	−0·9	−0 8	0·0	−0·2
1844-'45	+1·0	+0·4	+0·5	0·0	−0·7	−0·1	−0·3	−0·8	−1·8	−1·2	−1·0	−1·6
Mean,	+0 7	+0·2	+0·4	−0 3	+0·1	−0·7	−1·3	−0·6	−0·5	−1 0	−0·1	+0·2

If we give weights to the annual means according to the number of observations, they would be one for the first and second years; three-fourths for the third year; one and three-fourths for the next year, and two for the last year. A general examination however shows that owing to the disturbing effect of the progressive change, the monthly means are very nearly of equal value, derived either from the bi-hourly or from the hourly series. It is also shown in the sequel that the lunar diurnal variation is nearly the same in the summer and winter seasons.

A comparison of the values of table No. VIII. among themselves, shows them to be very irregular, although derived from many thousand observations. A five year series of observations seems barely sufficient to exhibit a tolerably regular progression. In the following table two groups have been formed, one of results from three years, 1840 to 1843, comprising 8797 observations; the other from the remaining two years, comprising 13248

observations. From these it appears, that the lunar diurnal variation during these two periods exhibit the same general character.

Lunar Diurnal variation during the periods 1840–'43 *and* 1843–'45.

Groups.	0ʰ	1	2	3	4	5	6	7	8	9	10	11ʰ
1840–'43.	+0·5	+0·5	+1·0	+1·2	+0·1	+1·0	−0·3	−0·2	−1·0	−0·3	0·0	+0·3
1843–'45.	0·0	+0·5	+0·7	+0·9	+0·4	+0·3	+0·5	+0·6	+0·1	−0·6	−0·6	−0·2

Groups.	12ʰ	13	14	15	16	17	18	19	20	21	22	23ʰ
1840–'43.	+0·8	+0·3	+0·4	−0·6	0·0	−0·9	−1·8	−0·5	0·0	−1·2	+0·2	+0·9
1843–'45.	+0·7	+0·1	+0·4	+0·2	+0·3	−0·4	−0·6	−0·7	−1·3	−1·0	−0·5	−0·9

Before proceeding to the analysis of the final result of table No. 8, the separate results were combined into summer and winter groups, the first comprising the months from April to September, the second group the winter months from October to March.

The results are exhibited in the annexed diagram A. The number of observations, about eleven thousand for each group, is evidently too small to eliminate the greater irregularities.

If there is any marked difference in the lunar diurnal variation in the summer and winter season, the summer range is slightly greater than the winter range. As to the epoch there is no doubt that in winter the lunar maxima and minima are earlier than in summer. It is a remarkable fact that the same feature shows in the lunar effect on the declination, namely, a greater amplitude in summer and an earlier occurrence of the maxima and minima in winter. The amount of the shifting of the two curves seems to be nearly the same.

From the ten years series of observations at Prague (1840–'49), Mr. Karl Kreil found a larger lunar effect in summer months than in winter.

Recurring to the final values of the lunar diurnal variation of the horizontal force, as given in table No. 8, they can be represented by the usual Besselian form of periodic functions.

The curve is double crested and is exhibited together with the observed values in the annexed diagram. It presents two maxima and two minima. (See diagram B.)

The lunar effect on the declination we have found also to present two maxima and two minima as stated in Part III. of the discussion.

An examination of the diagram just referred to, shows;—

Principal maximum,	2ʰ	52ᵐ	after	upper	culm.;	+0·78	scale divisions.
Secondary "	1	7	"	lower	" ;	+0·51	"
Principal minimum,	6	41	"	"	" ;	−0·87	"
Secondary "	8	19	"	upper	" ;	−0·45	"

The epoch of the horizontal force tide for the high values is nearly two hours after the culminations, and for the low values it is seven and a half hours after the same phases.

For Makerstoun in Scotland, at Sir Thomas M. Brisbane's observatory in 1843–'46, Mr. J. A. Broun found (Trans. Royal Soc. Edinburgh, vol. xix, p. 2, 1849) the smaller maximum of the horizontal force two hours after the upper culmination, the greater maximum an hour and a quarter after the lower culmination; the smaller minimum eight hours after the upper culmination, and the greater minimum nine hours after the lower culmination.

At Prague all extremes appear from two to three hours later. Mr. Kreil (Denkschriften of the Imp. Acad. of Sciences at Vienna, vol. v, 1853) found from the ten years series at Prague (1840–49) maxima of horizontal force between four and five hours after the upper an lower culminations, the latter being the greater of the two, and minima between ten and eleven hours after the same epochs, that after the upper culmination being the greater of the two.

From the Toronto observations Major General Sabine deduced a formula giving a curve of which the general features are in exact accordance with those deduced from the Philadelphia observations, namely, a principal maximum after upper culmination, followed by the secondary minimum; the secondary maximum after the lower culmination followed by the principal minimum. The times and amount of these values are compared in the following table (No. 10).

TABLE No. 10.—*Comparison of the lunar diurnal variation of the horizontal component of the magnetic force, as deduced from* 22045 *observations between* 1840 *and* 1845 *at Philadelphia, and as deduced from* 34303 *observations between* 1844 *and* 1848 (*a* 5 *year series*) *at Toronto, Canada.*

	Philadelphia.	Toronto.
Time of principal maximum,	$2^h.9$ after U. C.	3^h after U. C.
" " secondary minimum,	8 ·3 " "	9 " "
" " secondary maximum,	1 ·1 " L. C.	2 " L. C.
" " principal minimum,	6 ·7 " "	8 " "
	In parts of the horizontal force.	
Amount of prin. max.	+0·000032	+0·000046
" " secon. min.	−0·000016	−0·000010
" " secon. max.	+0·000019	+0·000024
" " prin. min.	−0·000032	−0·000041
	In absolute measure.	
Amount of prin. max.	+0·00133	
" " secon. min.	−0·00068	
" " secon. max.	+0·00078	
" " prin. min.	−0·00133	

Probable error of any single representation of the Philadelphia values $=\pm 0{\cdot}25^{\text{div}}=\pm 0{\cdot}000009$ parts of the horizontal force $=\pm 0{\cdot}000038$ in absolute measure.

Investigation of the horizontal force in reference to the lunar places.

The following process of reduction has been adopted. After marking the days of the full and new moon and also the days preceding and following, the daily means of the horizontal force readings were taken (already corrected for difference of temperature and progressive change) for the place of any disturbed observation, the monthly normal, belonging to the respective hour, was substituted before taking the daily mean. All accidental omissions in the record of the hourly or bihourly series were supplied by the hourly normal of the month. The means thus obtained, are independent of the solar diurnal variation. The monthly normal was next compared with each daily mean and the differences (normal minus mean) were tabulated.

A positive sign signifies a greater, a negative sign a less force than the normal value. As the results deduced from a single year are yet too much affected by the incidental irregularities of the observations, the collective results from the five year series (1840–45) are herewith presented.

TABLE No. 11.—*Influence of the lunar phases on the horizontal force.*

	s d	Parts of the h.f.	In absol. meas.
One day before full moon,	−1·0	−0·000036	−0·00015
On the day of " "	−1·5	−0·000055	−0·00023
One day after " "	−0·2	−0·000007	−0·00003
One day before new moon,	+0·0	+0·000000	+0·00000
On the day of " "	+2·4	+0·000091	+0·00038
One day after " "	+0·9	+0·000033	+0·00014
Difference for new-full moon,	3·9	0·000146	0·00061

The average number of observations from which any one of the above six means were deduced is over 800 and the probable error, in scale divisions, of any one of the results is $\pm 0{\cdot}7$ (nearly).

From the Makerstoun observations Broun found for the years 1843–46 a minimum at the time of the full moon and a maximum at the time of the new moon; Kreil, from the Prague observations, between 1843–46 found the same result as given above. It must be remarked, however, that after the year 1848, Kreil found that the signs were reversed, and consequently it appears that the lunar influence on the horizontal force is subject to a cycle of short period. This last remark does not apply to the effect of the moon's declination and variation in distance.

Influence of the moon's changes of declination on the horizontal force.

The method of investigation is precisely the same as that adopted for the phases. We find:

TABLE No. 12.

	s. d.	
One day before the greatest north declination,	+0·8	
On the day of " " " "	+0·6	Mean +1·1.
One day after " " " "	+2·2	
Two days after " " " "	+0·9	
On the day of the moon's crossing the equator,	−1·2	Probable error of any one result ±0·9.
One day before the greatest south declination,	−3·4	
On the day of " " " "	−0·9	Mean −0·6.
One day after " " " "	+0·9	
Two days after " " " "	+1·0	

It seems probable that the greatest effect takes place rather a day after than on the day of the moon's greatest declination. Taking means as indicated in the above table we find about the time of the maximum north declination an increase of horizontal force of 1·1 scale division (or 0·000040 parts of the horizontal force); at the time of the moon's crossing the equator the force is decreased 1·2 scale divisions (or 0·000044 parts of the horizontal force). The horizontal force also appears decreased about the time of the moon's greatest north declination, the amount is about half that of the other two cases and is somewhat doubtful, by an apparently excessive value on the preceding day.

According to Broun there is at Makerstoun a maximum horizontal force at the time of the moon's greatest north and south declination with a minimum force at the time of her crossing the equator; in two cases, therefore, viz: for north declination and no declination the Makerstoun and Philadelphia results agree, while in the third case they disagree or remain doubtful. Kreil's results, from the Prague observations, do not appear to me sufficiently decisive and regular to admit of comparison.

Influence of the moon's variation in distance on the horizontal force.

By a similar process of reduction as that followed in the preceding investigation we find

	s. d	
One day before perigee,	−1·5	s. d.
On the day of "	−1·9	mean −1·8
One day after "	−2·0	
One day before apogee,	+2·3	
On the day of "	+2·3	mean +2·4.
One day after "	+2·7	

The probable error of any one result is about the same as in the preceding results (tables XI. and XII). The results for va-

riation in the moon's distance are more consistent and satisfactory than those depending on the phases and declination changes. The lunar effect is to diminish the horizontal force by its 0·000066 part in perigee and to increase it by it 0·000088 part when she is in apogee.

The Prague results are the same, viz: a greater horizontal force at and after the moon's apogee than at and after her perigee; a three years series of observations at Milan, however, do not agree therewith. In no branch of magnetic research would additional results from independent observations, particularly at stations widely apart, be more acceptable and valuable than in the study of the lunar effect in its various manifestations.

ART. XXXV.—*On Arithmetical Relations between Chemical Equivalents;* by M. CAREY LEA, Philadelphia.

IN previous numbers of this Journal I have published a series of papers on this subject, one point of which has been subjected to criticism; namely, that I have introduced, in order to complete certain series, negative equivalents, as is alleged, without giving any explanation of such a conception.

In answer, I may observe, that I have not used the expression attributed to me. I have never once in the whole series of papers referred to, spoken of negative equivalents. Such an expression would I conceive, be an absurdity. Any negative quantity taken in an isolated sense is, as Carnot has proved, an absurdity. But I have pointed out that by carrying certain decreasing arithmetical series to successive terms, the equivalents of well marked series of chemical bodies were obtained, and that finally when we reached a point at which the last term was less than the common difference, the series might yet be continued, and the equivalents of other elements, admitted by all chemists to belong to the same natural group, might be obtained, although with negative signs affixed. For example, if commencing with antimony, we subtract a number corresponding nearly with 45 we obtain in succession the equivalents of arsenic and phosphorus. With phosphorus we reach a term, the numerical value of which is less than the common difference. We cannot therefore carry the series forward another term without encountering negative numbers. Nevertheless there remains another member of the group, nitrogen, intimately bound to it. Is it not then a matter of great interest to observe that this last member of the group, apparently cut off from it, is reached, although with a negative sign, by simply carrying the series another step?

There next arises the question "What signification is to be attached to a quantity presenting itself under these circumstances with a negative sign? I need not remark that the theory of negative signs has been a stumbling block in the way of mathematicians and has given rise to long disputes between men of the most exalted intelligence; such as those which occurred between Leibnitz and Bernouilli, and between Euler and D'Alembert.

But the ideas which prevail at the present day are sufficiently clear to throw a light on this subject, and I cannot do better than quote verbatim the following passage which I translate from Carnot.

"The true sense which is to be attached to this expression, (that of a negative quantity), is that this absolute quantity does not belong to the system on which the reasonings have been established; but to another which stands with it in a certain relation; such that in order to render applicable to it the formulas found for this first system, it is necessary to change from + to − the sign which precedes it.

"But from the necessity of placing for example $-y$ in the place of $+y$ it does not follow that the quantity represented by y has become negative; but only that, as has just been proved, it is the difference between two other quantities a, z, of which that which was the greater in the system on which the reasoning was established and the formulas found, has become the least in the system to which it is desired to apply these formulas. For the quantity represented by y being constantly, by hypothesis, the difference between the two quantities, a, z, will be now $a-z$, now $z-a$, according as z is less or greater than a; but in all cases it will be the greater of these two quantities less the lesser, and consequently always positive, and the expression $-y$ will never be anything more than a simple algebraical expression, without signification in itself but having the property that by being substituted in the formulas found, in place of $+y$, it will render them applicable to cases not previously foreseen, or which at least were not included in those on which the reasoning was primarily established."*

The above is precisely the case in the question of equivalents before us. The above quantity, a, may be taken as the common difference in a series of equivalents, and z any term in that series, y the following term. Now the sign of y depends upon the relative greatness of the numbers a and z, but in the words just quoted, "*from the necessity of placing $-y$ in the place of $+y$ it does not follow that the quantity represented by y has become negative.*"

The criticism to which I am now referring has probably been founded upon the very general assumption that a negative quantity is less than nothing. This assumption is so plausible as to

* Carnot, Géometrie de Position, Paris An xi (1803). Dissert. Prél. xix.

have deceived many eminent mathematicians and even Newton himself and Euler. But D'Alembert and Carnot have both pointed out its erroneous nature. D'Alembert states the proportion $1:-1::-1:1$, and observes that if -1 be less than nothing, then it must be less than $+1$, and we should have a greater number standing to a less in the same relation as a less to a greater, which would be an absurdity. Therefore -1 is not a less number than $+1$. Carnot considers this reasoning of D'Alembert unanswerable, and has himself proved the same in an equally ingenious manner. If -3 be less than nothing it must be less than $+2$. But $(-3)^2=9$ and $(+2)^2=4$. Therefore the square of the less number would be greater than the square of the greater, which is absurd.*

Clearly, therefore, it cannot be maintained that negative numbers are less than nothing. Taken in an isolated sense, they are mere mathematical abstractions, but considered in connection with the operations by which they were produced, they are full of significance.

Philadelphia, Sept. 26, 1862.

ART. XXXVI.—*Description of Calamoporæ, found in the gravel deposits near Ann Arbor, Michigan, with some introductory remarks;* by CARL ROMINGER, M.D.

THE alluvial deposits are to me at present the only accessible source for palæontological study, the nearest stratified rocks being 40 miles distant from my location. In passing a gravel-pit, I used to feel a sort of dissatisfaction, because strata of older deposits were hidden from my view, but now, by necessity, I have learned to admire the gravel exposures as a sort of a cabinet, comprising the whole Palæozoic fauna. It is true, that cabinet is in bad order, but fortunately its specimens are so well labelled, that even the effects of a deluge could not destroy the marks, and so, with care, order can be restored. The genus *Calamopora* or *Favosites* is very abundantly represented and its silicified specimens are frequently so finely preserved that, to study their organization, no better material could be wished for.

* Another argument advanced by Carnot and which is equally cogent, is the following which I quote in the original. "Je dis d'abord que la première de ces notions est absurde, et pour la détruire, il suffit de remarquer qu' étant en droit de négliger dans un calcul les quantités nulles, par comparaison à celles qui ne le sont pas, à plus forte raison devrait-on être en droit de négliger celles qui se trouveraient moindres que 0, c'est à dire les quantités negatives; ce qui est certainement faux: donc les quantités negatives ne sont pas moindres que 0." Op. Cit. ix. See also Maseres, "On the use of the Negative Sign." The position assumed by D'Alembert and Carnot appears to be received by modern mathematicians as correct. See remarks of Mr. Galloway in Brande's Dictionary, Art. Negative Numbers.

The following pages will be a description of these remains, and I hope that my observations, although concerning objects which are generally well known, will add something to our knowledge.

Calamopora is defined by Goldfuss as a corallum composed of tubes, which are connected by lateral perforations in the walls, and divided into compartments by transverse diaphragms.

Within these limits he included the genus Chaetetes or Stenopora, supposing its walls to be perforated, but it is now sufficiently ascertained that the coral described by him as *Calamopora fibrosa* has no lateral communication between its tubes.

Milne Edwards, in his Monograph of British Devonian corals, describes and delineates a *Favosites fibrosus*, with lateral pores, and identifies his specimens with Goldfuss's figs. 3*a* and *b*, Tab. 28, but the correctness of this observation is very doubtful; at all events, the specimens from the Eifel, and those which Goldfuss had from Lexington, Kentucky, do not exhibit such perforation.

The distinction made between Chaetetes and Stenopora brings all the American forms, and those from the Eifel, to the latter genus, leaving for Chaetetes only the Russian specimens, which I have never had an opportunity of seeing.

Besides the exclusion of those forms to which the established generic character of Calamopora would not apply, a number of subgenera have been created from the remaining material.

Alveolites comprises Calamoporæ with depressed tubes and similar cell-mouths opening obliquely to the surface, and forming a projecting lip with the exterior half. The connecting pores are proportionally larger and more irregular than in ordinary Calamoporæ, and also the diaphragms are less regular. Its tubes are frequently flexuous, with the side-walls intimately united, and part of the younger tubes appear to be side branches of the older tubes, but simple side-walls and an increase by division of the older tubes are never observed, the walls having always in the centre a distinct line of demarcation.

Alveolites forms generally incrusting masses of laminated structure, but occurs also in the ramose form, which latter is only with difficulty distinguished from a second subgenus, the

Limaria or *Cladopora*, *Striatopora* and *Cœnites*, all of which names are designed for fossils of the same organization.

Limaria is a Calamopora growing in small branches, with very massive tube-walls, and expanded cell-mouths of rounded or transversally elongated shape. Its side pores are large and not numerous, its tubes augment by interpolation, sometimes opening at their lower ends into the side-walls of older tubes, as in Alveolites. Transverse diaphragms perfect, or represented by lateral linguiform projections, but frequently wanting.

Cladopora is said to differ from Limaria by a different shape of the orifices, but it is impossible to draw a line of division between the different forms.

Striatopora is separated on account of its having longitudinal striæ on the inside of its tubes, but this character is essential to Calamopora and to all its sub-genera. In some specimens or species this striation is somewhat obscure, but this does not alter the general rule.

Michelinia includes Calamoporæ with very large tubes and compound vesicular diaphragms. The longitudinal striæ in its tubes are more numerous than in other Calamoporæ and the side pores are remarkably small and irregularly disseminated.

The separate tubes of some corals, connected by lateral processes and with constrictions at various intervals, named by Billings *Haimeophyllum*, under certain circumstances coalesce, and become connected by lateral pores, assuming altogether the form of a Michelinia.

Some other subgenera have been dissevered from Calamopora without any proper justification.

Emmonsia is characterized by tubes in which the ordinary simple diaphragms are in part or wholly replaced by compound and imperfectly developed diaphragms. This character is so little constant that, in the same tubes, a succession of perfectly regular simple diaphragms may be observed, while in previous or subsequent periods of growth only compound and partial diaphragms were deposited.

Astrocerium is not entitled to more credit; it is based upon the presence of rows of spinules on the inner surface of its tubes. Spinules are decorative organs, noticed in a number of other Calamoporæ, which the author allows to bear their old name; these spinules are also not equally well developed in all specimens of the same species and are often obliterated by the effects of petrification.

A character upon which alone a generic distinction is based should not be subject to obliteration by want of development or by the effects of petrification.

Before entering upon a detailed description of species, I have to make some remarks upon the value of the number and disposition of the lateral pores, for specific distinction. It is desirable, that each species of Calamopora should have certain peculiar features, with regard to the size, number and disposition of its lateral pores, which can serve as subordinate characters, for distinction of one kind from the other, but most writers have placed too much importance upon these characters. The tubes of a Calamopora form irregular polygons, which of itself excludes a regularity in the number of pore-rows on a side; but suppose the polygons were regular—the number of rows in a species does not seem to be constant, for the circumference of a tube.

The same want of precision exists with regard to the position of pores on the sides or on the angles.

The organization of the animal does not seem to have been such as to determine, by a sort of mathematical necessity, the position of the pores; on the contrary, it appears that the animal was at perfect liberty to leave *ad libitum* such openings in its walls.

Calamopora favosa Goldfuss, Tab. 26, f. 2.

To determine the identity of fossils described by European writers with those found here, is always connected with some difficulty, but, in this case, the fossil itself is of American origin, and so, by looking over the specimens from the locality indicated (Drummond's Island), *Calamopora favosa* can easily be pointed out. According to Goldfuss's figure its tubes are a little over 3 millimeters wide, and in his rather short description he designates convex diaphragms and two opposite rows of pores on each side as the distinguishing characters of it. It will not appear superfluous, to add to this some more special observations. The tubes, which in a given specimen are all of similar size, have a very variable diameter, between the extremes of 4 millimeters and 1½ millimeter; for example I observed a tube measuring 9 millimeters in one specimen, the tubes of which had an average size of 4 millimeters. The inner side of the tubes is densely covered with spinules, some of which are bifurcated, and which also extend over the upper face of the diaphragms.

The spinules are placed in about 12 longitudinal rows, separated by as many longitudinal sulci, and a transverse order also, corresponding with the lines of growth seen on the outside, can be noticed in the arrangement of the spinules.

Under the magnifier this position of the spinules in rows is not so obvious as with the naked eye, as they appear then more irregularly dispersed. Pores of moderate size are disposed over the sides in 1, 2, or 3 irregular rows, but not as Goldfuss asserts, in pairs; pores placed in pairs are sometimes seen, but this is by no means the rule.

The diaphragms are subject to many variations, some are almost flat, others form a high, rounded or transversely elongated cone, the top of which is often deeply impressed; this impression protrudes on the lower side as a rounded elevation, of which Goldfuss gives a good representation, Tab. 26 fig. 2, 6. Sometimes in the centre of this depression a hole is left open, or it is found closed up subsequently with a solid globular piece.

Marginal depressions in the diaphragms, similar to those figured by Goldfuss in his *Calamopora alveolaris*, are seen in different degrees of development. Sometimes they are hardly to be noticed, at others they become large and give the end cells a starlike appearance. Frequently 12 such depressions encircle the diaphragms, but often less.

Characteristic of this species, are obtusely polygonal concentric rings of growth marking both faces of the diaphragms, and an obscure radial striation, which becomes more distinct on the eroded surfaces.

Usually three or four diaphragms are placed in a space equal to the diameter of a tube, but sometimes only one, for the same distance. The corallum is found in tabular fragments of several inches thickness and nearly parallel tubes, or in biconvex cakes with the lower side surrounded by an epitheca, which however is rarely well preserved.

Calamopora Niagarensis Hall, and part of *favosa* Hall; *Calamopora Gothlandica* auctorum: *Dania Huronica?*

I adopt the name *Niagarensis*, in preference to *Gothlandica*, because the first name is less abused, while the latter has been applied to so many different species that nobody knows which is the genuine. Even Goldfuss himself confounded different corals under that name. The Eifel specimens of *Calamopora Gothlandica* are at all events totally different from the Niagara specimens.

Under the name *Niagarensis*, I comprise forms which are found associated, and do not differ from each other, except in the size of their tubes, which varies from two to four millimeters in different specimens. The inside of the sharp-edged polygonal tubes is covered with small delicate spinules; some specimens appear to be entirely smooth, but, even in these, usually some tubes can be found in which the spinules are preserved.

Pores are small, not crowded, and with no elevated border, from 1 to 4 rows may be counted on a side, the number of rows on the circumference of a tube does not seem to exceed 15, more frequently a smaller number occurs. Diaphragms flat, sometimes slightly concave, or flexuous, in consequence of the development of a few marginal depressions; or stellate, if these depressions have become more numerous and more regular. Most frequently from 5 to 12 such depressions are observed, but in some tubes I have noticed more than 12.

All these variations in the diaphragms can be observed at once in a single specimen, but most frequently the diaphragms are perfectly flat, horizontal, or occasionally oblique, their upper face is also decorated with spinules, which however are seldom preserved.

Distance of diaphragms variable from the thickness of paper to more than the diameter of a tube. This variation occurs sometimes in the prolongation of one and the same tube, or cluster of tubes.

A number of specimens, and those with closely approximated diaphragms in particular, have a laminated structure, and the side pores are disguised by the densely crowded diaphragms, or

by incrustation. I strongly suspect that by misapprehension of such specimens the genus Dania has been called into existence, and will finally have to be erased from the list of names.

The corallum is found in tabular undulated fragments, with parallel tubes; or in placentiform expansions, with flattened or conical base, on which sometimes remains of an epitheca are preserved. *Calamopora Gothlandica* from the Eifel differs from it, by the inequality and more rounded nature of its tubes, by its tuberose or piriform mode of growth, by much coarser and more numerous spinules on the side-walls, by much larger and more numerous lateral pores, which are surrounded by a shallow excavation, from the upper end of which a large spine generally protrudes.

Calamopora venusta Hall.—*Astrocerium venustum* Hall, is a very near relative of the two former species. Its tubes are about one millimeter wide, sometimes less.

Twelve longitudinal rows of spinules are planted on the inner circumference of the tubes, which often grow so long as to reach the centre. The upper face of the diaphragms is also spinulous. The diaphragms are flat, but often also of warped aspect, from the presence of lateral depressions. Pores are disposed along the sides in one or two rows.

In some specimens the tubes are more than one millimeter wide, and the spinules not so largely developed, but otherwise they do not seem to differ much. It occurs in our gravel banks usually in fragments of larger masses, or in placentiform laminate expansions with an epitheca on the lower side. The rock enclosing the three preceding Calamoporæ is so similar to the rocks of Drummond's Island that specimens laid side by side cannot be distinguished from each other.

The following species of Calamopora occur in a siliceo-calcareous rock, which, judging from the character of its fossils, is identical with the Corniferous limestone of New York and Canada.

Calamopora hemispherica Yandell and Shumard; *Favosites alveolaris* Hall, Geol. Report New York, 4 Distr.; *Emmonsia hemispherica* Milne Edwards and Haime; *Favosites hemispherica* Billings, Canad. Journ. 1859.

This coral is found in a number of different varieties, which are so intimately connected by intermediate forms that it would be unnatural to undertake a division into several species. Milne Edwards enumerates three species, which are distinguished by the size of the tubes, by more or less regularity in the diaphragms, and by the number of pore-rows on a side, all of which characters are very variable, even in single specimens, and consequently cannot be relied on. Specimens with tubes nearly three mil-

limetres wide, and others in all gradations down to tubes of one millimetre, or even less, are equally common.

A certain size of tubes is always predominant in specimens, but smaller and larger ones are found intermingled. Exteriorly the tubes are smooth, or marked with transverse lines of growth, polygonal; interiorly, frequently rounded, with from 12 to 14 linear longitudinal sulci, including in this number the lines formed by the angles of the polygons. Most characteristic of this species are horizontal, or variously oblique or flexuous, linguiform lamellæ, which project from the side-walls of the tubes in various degrees of development and of multitude.

These lamellæ are perfect analogues of the spinules of the above described species from the Niagara group, and must not be confounded with the ordinary diaphragms, although they can take their place and function.

In some specimens regular diaphragms divide the tubes, and the intervals between them are found either studded with shorter lamellæ, or interrupted by partial compound diaphragms, formed by the enlarged and coalesced lamellæ. In other specimens no regular simple diaphragms can be found, and the irregularly coalesced lamellæ replace them altogether; but even in those specimens in which, at certain periods of growth, no regular diaphragm can be noticed, successively, or abruptly, the tubes may alter their appearance, and, for a while, only regular simple diaphragms may be seen, with the intervals between them entirely smooth. This circumstance proves satisfactorily that the different degrees of development of these organs, far from being of generical importance, are not even constant in the prolongation of one and the same tube.

In some specimens the lateral lamellæ form twelve tolerably regular longitudinal rows, which are separated by the longitudinal furrows, but in other specimens smaller and larger lamellæ, horizontal, oblique, or flexuous, are dispersed in perfect disorder, forming by their coalescence a coarse cellular tissue, rather than a series of diaphragms. The diaphragms formed of lamellæ more equal in size and position, have a stellate surface, from the cicatrices indicating the outlines of the component lamellæ. Milne Edwards, probably having in view this kind of diaphragms, speaks of "12 vertical lamellæ reaching to the centre of the tabulæ," but the vertical lamellæ and the tabulæ are in this case one and the same thing.

The pores form from 8 to 12 rows on the circumference of a tube, are large and numerous; surrounded by a prominent rim, or not. They seem to be more numerous in the tubes with complicated diaphragms, than in those which have them more simple.

By disease, parts of some specimens of this coral have become so transformed that they would not be suspected to be Calamoporæ, if they were not connected with tubes of regular form. Casts of such specimens are represented by a network, composed of geniculate, nodose, vertical columns, which are connected by numerous horizontal side branches, equally thick with the columns. The walls of the tube and its lamellæ are thickened enormously at the expense of the openings, while at the same time, the side-pores enlarged, and assumed the form of connecting tubes. A similar disease is noticed in some ramose specimens of Calamopora, from the Eifel, which appear like solid branches, perfectly, penetrated by tortuous worm holes.

The external form of this coral is indicated by its name. Rarely remainders of an epitheca can be noticed, which seemed to be restricted to a small root portion.

Calamopora epidermata; Calamopora Gothlandica Billings, Canad. Journal, 1859, p. 104.

Billings confounds this coral with specimens of the Niagara group as well as with Eifel specimens, but with neither of them has it much similarity. By having lamellose projections on the side-walls instead of spinules, it differs from both, and shows its close affinity to *Calamopora hemispherica*, from which it differs, by a different mode of growth, by larger tubes, by regular simple diaphragms, and by smaller less numerous side-pores; but because *C. hemispherica* sometimes has also its diaphragms more regular, and does not differ very much in the size of its tubes, it becomes sometimes very difficult to determine, in fragments, to which species they belong. It grows in placentiform, lobate expansions, with a conical basal portion; from the surface of these expansions, new expansions sprout up in terrace-form. The whole underside of the mother expansion, as well as of the terraces, is covered with a concentrically wrinkled epitheca. The tubes which have in *C. hemispherica* an inclination to form an arch directed outwards, are in this species more bent upwards, which is the cause of its having a flattened placentiform surface.

It is already mentioned, that lamelliform horizontal projections entirely similar to those of *C. hemispherica* are placed on the inside of the tube-walls, but these remain in the form of linguiform squamæ, and do not often help to form the diaphragms, which are perfectly regular, flat, or warped by the development of some lateral depressions. These depressions are in this species never so numerous and so regular as to give the end cells a star-like aspect.

Distance of diaphragms not large, usually three or four in the space of a tube-diameter, which varies from two to three milli-

meters, in the same specimen. Twelve longitudinal linear sulci are well marked.

The pores are moderate in size and in number, surrounded by a prominent rim and forming one or two irregular rows on each side.

Calamopora Winchelli, n. s.

Tubes rounded, or obtusely polygonal, from three to four millimeters wide, interspersed with many smaller ones. Walls marked with 12 longitudinal sulci but otherwise smooth. Diaphragms distant, simple, flat, promiscuously horizontal, or in all degrees of obliquity; frequently they become flexuous, by lateral depressions, or one of these depressions is so strongly developed as to occupy the whole diaphragm, and to transform it into a funnel.

Pores are large, surrounded by a rim, moderately numerous, forming from 8 to 12 rows on the circumference of a tube.

The corallum occurs in irregular subglobose masses. A piece of epithecal crust preserved in a specimen has, besides the concentric lines of growth, also fine longitudinal striæ. It is found enclosed in the same rocks with the formerly described species; one specimen I took from a sandstone boulder, containing a number of fossils characteristic of the Oriskany sandstone.

Calamopora Canadensis; Fistulipora Canadensis Billings, Canad. Journ. 1859, p. 98, fig. 1.

It grows in large undulated expansions, of a thickness variable from a few lines to more than an inch. From the surface of these similar expansions sprout up, forming gradually a cavernous superstructure, the floors of which, on the under side, are all covered with an epitheca, so thin that the outlines of the tubes show through it. Its tubes are of two sizes, and so disposed as to give to the surface the appearance of a Heliolites. The larger ones are perfectly round, and measure about one millimeter, the smaller ones are angular, and are only half a millimeter wide.

Twelve distinct longitudinal ridges can be observed on the casts of the larger tubes, and also on the smaller tubes longitudinal striæ can be noticed.

Both kinds of tubes are divided by regular perfect diaphragms. In the larger tubes, the intervals between the diaphragms exhibit a small number of linguiform lamellæ, similar to those of *Calamopora hemispherica*, or *C. epidermata*.

Pores surrounded by an elevated border, quite numerous on the larger tube as well as on the smaller ones.

Calamopora heliolitiformis, n. s.

Differs from the former species by having larger tubes, and by its growth in subglobose masses and not in flat expansions.

The larger round tubes measure not quite two millimeters, the smaller angular tubes one millimeter. Diaphragms of the smaller tubes simple, straight, and somewhat distant, in the larger tubes simple and compound or imperfect diaphragms are intermingled as in *Calamopora hemispherica*.

Pores are large and numerous, surrounded by a prominent rim, placed in a single row on the sides of the smaller tubes; the number of rows on the circumference of the larger tubes I could not accurately ascertain. Also longitudinal sulci are noticed, but in the specimens they are not plain enough to be counted.

Calamopora basaltica, Goldfuss Tab. 26, fig. 4.

Occurs in tuberose or pyriform, glandular masses, with more or less unequal polygonal tubes, from one to two millimeters wide, ascending in a gentle curve, from the interior to the outside.

Diaphragms flat, simple, or more frequently compound, distant about one millimeter. In parts of the surface, all the tube-mouths are found closed up by opercula of a more substantial and more regular construction than the ordinary diaphragms. The latter are compounded of from five to eight linguiform lamellæ, unequal in size and in level, so as to form by coalescence an irregular angular surface; the opercula are formed by 12 such lamellæ, equal in size and in level, the sutures of which give them a regular stelliform appearance. The centre of the operculum is formed by a circular piece of concentrical structure, and not by the coalesced acumina of the lamellæ composing the external ring.

A similarly constructed operculum is described in *Callopora elegantula* by Hall (Palæontology of New York, vol. ii, p. 144). The opercula, as well as the ordinary diaphragms, can sometimes be observed in the young state, in which the constituent lamellæ have not yet grown so far as to become contiguous, therefore in the centre a corresponding stellate opening is seen.

The compound diaphragms of this species are always in regular superposition, and do not exhibit the cellulose confused condition which was described in *Calamopora hemispherica*. From the side view they appear to be simple, and only rarely some isolated lamellæ are found protruding in the intervals between them.

Pores form one, sometimes two, rows on each side.

The adjoining tube-walls are separated at the surface by very plain lines of demarcation which are sharply polygonal, while the openings of the tubes often have a more rounded aspect.

Calamopora turbinata Billings, Canad. Journ., 1859, p. 109; Ib. 1860, May number.

This peculiar Calamopora is a very near relative to *C. basaltica*, and differs from it only in external form, which is either turbinate, like a turbinate Cyathophyllum, or it forms large lenticular masses, with coarse rounded folds on the lower side which is generally exposed, while the upper side is almost invariably adhering to the enclosing rock; or in other cases, the internal portions of the coral are decomposed, and only the external ends of the tubes, which are strengthened by their massive opercula, are left in the form of excavated horns, or more expanded funnels or dishes. Billings has described the corals so well that any farther remark is superfluous. He calls the appearance of an operculum an epitheca, which word should be restricted to a different sort of an envelope.

It is rarely found silicified, in association with the other Corniferous limestone fossils; it is very common in calcareous fragments containing immense numbers of broken Brachiopods, Crinoidal stems, and Bryozoa, belonging to the lower strata of the Helderberg group.

Calamopora polymorpha belongs to more destructible *calcareo-argillaceous* strata, and is very poorly preserved in our gravel. The ramose forms known as *C. cervicornis*, *C. reticulata*, and *C. dubia*, with a number of allied forms, are found finely preserved, but I reserve their description for some future communication, which will also embrace the numerous varieties of Limaria, and the ramose forms of Alveolites.

Michelinia convexa D'Orbigny; Billings, Canad. Journ., 1859, p. 112.

It is not unfrequently found, but rarely well preserved.

Omitting a general description, I have only to mention a remark of Mr. Billings, that Michelinia differs from Favosites by having the vertical lamellæ represented by vertical striæ, while in Favosites series of minute spinules form the equivalent. But *Michelinia convexa* and also *M. favosoidea* have the inside covered with just as many rows of spinules as they have longitudinal striæ, because every interval between two striæ bears a row of spinules. On the other hand the striæ are also well enough developed in Calamopora, only less numerous than in Michelinia.

Michelinia intermittens Billings; Canad. Journ., 1859.

A coral which corresponds perfectly with the description given by Mr. Billings is not rare here.

Its tubes are frequently contiguous and connected by lateral pores, which are placed in the intervals between the constrictions; diaphragms vesicular, longitudinal striæ indistinct, and spinules irregularly dispered over the interior of the side-walls.

In parts of the same specimens the tubes are free, only connected by lateral processes, and exhibit all the characters described by Billings in *Haimeophyllum ordinatum* (Canad. Journ., 1859, p. 140). This species consequently has to receive the name Haimeophyllum, the affinity of which to Michelinia is already mentioned in Mr. Billings's essay.

ART. XXXVII.—*On a remarkable form of Rotation in the pith cells of Saururus cernuus;* by GEORGE C. SCHAEFFER, M.D.

WHILE examining the intimate structure of various plants, I discovered, in the year 1854, a peculiar motion in some of the pith cells of *Saururus cernuus*, which was so different from any thing before described that it seemed to be quite abnormal. Continued observation for eight years has shown however that, for this plant at least, the phenomenon is constant, while an equally long continued examination of the writers on such subjects, has proved that no record of this appearance has ever been made. As a mere microscopical curiosity the fact might be deemed worthy of notice, but the remarkable similarity to a motion which has been considered as invariably connected with a distinct and peculiar vegetable function, seems to render its record needful for the true advancement of vegetable physiology.

The *Saururus cernuus*, like many other aquatic or marsh plants, has a pith, the cells of which are not in complete juxtaposition, but separated in part by vertical air passages which are as regularly built around by the cells as a chimney is by its bricks, with this difference, however, that the cells are arranged directly one above another, and do not "break joint" as the bricks would in any properly constructed chimney—no fault in Nature's workmanship, we should remark, since the pith is a mere filling in, surrounded by a much denser and more solidly built structure.

The cells in which the above mentioned motion occurs are not those from which the party walls of each air passage diverge, but those forming the middle of the wall between any two contiguous channels; they seem to be smaller and *younger* cells than the others.

In all ordinary cases of *cyclosis* the motion is along the walls of the cell, coming and going in paths which are, for the time at least, permanent. But in the *Saururus* the granules lie in the centre of the cells above described and their motion is of a quite different character. To those familiar with microscopic observations, we may best describe this motion as perfectly identical with that seen in the, so-called, vesicles, in the ends of *Closte-*

rium, which has been aptly styled "swarming" by the English and Germans. The granules are quite minute, rounded in form and rather unequal in size. Sometimes a cell is seen in which all motion has ceased, in such cases the granules are always closely crowded together in the centre of the cell.

The time during which this motion continues is quite remarkable. Specimens of the plant kept for several days in water never fail to show it, while the proper pith cells of all parts of the plant, even of the blanched portions of the stem growing beneath the mud, seem equally active. Indeed no form of *cyclosis*, of which this is undoubtedly one, is so easily demonstrated.

The nature of the granules however is not so readily determined, for they do not show the starch reaction with tincture of iodine, neither are they colored as proteine compounds, (and such I had at first supposed them to be,) would be under this reagent. There is however a remarkable difficulty, common also to many others, in applying chemical tests to sections of this plant, and this consists in the rapid discoloration of the specimens, owing to the presence of tannic acid which acts upon the iron of the cutting instrument. It is quite certain however that the granules are neither starch nor proteine, whether they are, the so-called, aleurone, I am unable to say.

To those familiar with the microscopic examination of fresh-water algæ, this "swarming" apart from the best known case of the *Closterium*, must be quite familiar—but such motions have always been considered as in some way connected with sexual reproduction. In the case in question however nothing of the kind can possibly occur—for the *Saururus* is, beyond a doubt, not only a phænogamous, but even a dicotyledonous plant, closely allied to the Pepper family. The cells in which this motion is seen are evidently smaller and younger than those in their immediate vicinity. Sometimes indeed two vertical rows of small cells show the same motion. The phenomenon in question would therefore merely indicate *active cell multiplication* and not *plant reproduction*, to which similar appearances have always been referred. With a somewhat extensive experience I am able to say that nothing of the kind has before been observed in phænogamous plants; yet it must be admitted that one single instance among them is sufficient to invalidate the inferences formerly drawn from algæ, as to the true meaning of this peculiar kind of motion.

I am more earnestly disposed to insist upon this, apparently, exceptional case because it confirms views long held and taught by myself as to the purely physico-chemical interpretation of most of the phenomena of vegetable life.

Washington, D. C., September, 1862.

ART. XXXVIII.—*On the occurrence of Triphyline at Norwich, in Massachusetts;* by GEORGE J. BRUSH.

IT is well known that a crystallized phosphate of manganese, iron, and lithia was found by Hitchcock and Hartwell, associated with the spodumene from Norwich, Mass., and that the crystalline form, and chemical composition of this substance have been investigated by several mineralogists and chemists. Prof. Dana and Mr. Craw* have shown this phosphate to be near triphyline, although, as Mr. Craw states, "the results of his investigation tend to prove a wide difference from that species rather than an identity with it." Prof. Shepard† refers the mineral to triplite, and calls attention to the circumstance that Mr. Craw's analysis connects the mineral with Damour's *alluaudite* rather than with *triphyline*. Dr. Mallett's‡ analysis does not differ essentially from that by Mr. Craw, and all these writers agree in considering the substance as an altered mineral.

Quite recently I have received from Prof. E. Hitchcock, Jr., some specimens which afford a solution of the question as to the character of the original mineral. Externally the specimens have an iron-black color; on the fracture, however, this iron-black substance is shown to be a mere crust, having but an imperfect cleavage, and passing gradually into a distinctly cleavable green mineral, which occupies the centre of the crystal. On examination, this central mass proves to be identical with *triphyline*, as will be seen by the following physical and pyrognostic characters: cleavage distinct in two directions, one quite perfect; color grayish-green, in thin fragments translucent; streak white; lustre vitreous inclining to greasy. H. = 5. Sp. Gr. = 3·534. Heated in the closed tube decrepitates, blackens, and gives a faint trace of moisture. On charcoal fuses readily to a black magnetic globule. In the forceps fuses, blackens, and in the outer flame gives reactions for lithia and phosphoric acid; in the reducing flame becomes magnetic. Fused in a glass tube with sodium yields a phosphid, which on treatment with water gives copious fumes of phosphuretted hydrogen. Dissolves in borax, soda, and salt of phosphorus, reacting for iron and manganese.

These characters are identical with those of the triphyline from Rabenstein in Bavaria, and the source of the altered phosphates of manganese and iron found at Norwich is thus shown to be *triphyline*. This fact is also of further interest, as being the first time that triphyline has been identified as occurring in this country.

Sheffield Laboratory, Yale College, Oct. 17th, 1862.

* This Journal, [2], xi, 99. † Rep. Am. Assoc. Ad. Sci., 6th meeting, p. 234.
‡ This Journal, [2], xviii, 33.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.—

1. *Contributions to the Spectral Analysis.*—In examining with the spectroscope a substance containing baryta, A. Mitscherlich observed two bright green bands which appeared to indicate the presence of a new metal. On further investigation it was found that the same lines were obtained, sometimes alone, sometimes together with barium lines, when a solution of chlorid of barium containing sal-ammoniac is employed. By means of a simple apparatus, consisting essentially of a glass tube closed at its lower end by a bundle of fine platinum wires and filled with the liquid to be examined, the author obtained colored flames of great intensity and long duration, the wires serving by capillary action to feed the flame of the burner. A mixture of 1 part of a concentrated solution of chlorid of barium with 20 parts of a solution of sal-ammoniac and 20 parts of chlorhydric acid containing about 20 parts of real acid gives the two green lines above mentioned. By employing solutions of the chlorids of calcium or strontium mixed with sal-ammoniac, new spectra are obtained which differ greatly from the ordinary spectra, but which are seldom quite free from them. Even to the eye alone the new flames differ in color from those obtained by employing the metallic salts without the addition of sal-ammoniac. From this it follows that the spectrum of the metals of the alkaline earths, is different from that of their chlorids. That the mere presence of sal-ammoniac without chemical action is not the cause of this difference, is shown by the fact that the ordinary or metallic spectra are not changed by passing the light through a flame containing sal-ammoniac. The spectra of protochlorid and subchlorid of copper were found to be different though usually more or less mixed in consequence of the reduction of the chlorid to subchlorid by heat. By introducing several substances into the same flame particular lines often vanish; thus the blue strontium line disappears when chlorid of copper, sal-ammoniac and chlorid of strontium are mixed. The chlorids of potassium and sodium give no spectra as such. The potassium spectrum vanishes when the chlorid is mixed with sal-ammoniac and chlorhydric acid. The sodium reaction is too delicate for this experiment, but the author found that light transmitted through the vapor of the ignited chlorid gave no sodium line.

From the above it follows that the metals do not give a spectrum in all their compounds, and that they do not give the same spectrum in different compounds, but that the character of the spectrum depends upon whether it is produced by the metal or by one of its compounds of the first order. It further appears that every compound of the first order, if it have a spectrum other than that produced by decomposition, must have a spectrum of its own. Metallic compounds are so easily reduced by the flame that we usually obtain only the spectra of the metals themselves. Light passed through ignited soda vapors, or vapors of the carbonate of soda, does not give the sodium line D, but the vapor of metallic sodium

at a low red heat exhibits this line distinctly. From this it follows that in those flames which exhibit the sodium line, metallic sodium, as such, produces the line in question, and since sodium has almost the greatest affinity for oxygen it follows that all spectra which are produced by oxyds are metallic spectra. The author further suggests that these experiments enable us to determine the affinities of the elements at the temperature of the sun's atmosphere by the spectral analysis. If, for instance, we observe the spectrum of a particular metallic chlorid in the sun's light, we should have to conclude that at the temperature of the sun's atmosphere the metal in question has a greater affinity for chlorine than potassium or sodium, since these exist as metals in the sun's atmosphere. Moreover we may hereafter, conversely, determine the temperature of the sun's atmosphere from the nature of the chemical compounds which exist in it, provided that we succeed in obtaining an approximately high temperature.

From the fact that free potassium and sodium exist in the sun's atmosphere, it follows that no free electro-negative body like oxygen, sulphur, &c., can be present, and not even enough to combine with all the sodium. Consequently all metals which are reduced from their compounds by sodium must exist in the sun's atmosphere in the free state.* The absence in the solar spectrum of the lines of a particular metal does not prove the absence of the metal itself, since it may exist in combination with some element, the compound itself exhibiting no spectrum. The many new lines recently discovered in the spectrum and to which no elements are known to correspond, may prove to be the lines of compounds of the first order of metals already known.—*Pogg. Ann.* cxvi, 499.

2. *Researches on the Solar Spectrum.*—After much delay we have received the long expected memoir of Kirchhoff on the spectrum, a work which has already passed to a second edition, and which can hardly fail to become the standard authority on the subject. The memoir in question is taken from the Transactions of the Royal Society of Berlin, and is accompanied by two plates of the spectrum and one of the apparatus employed. The plates are unfortunately not colored, and are lithographed instead of engraved. They represent only the portion of the spectrum which extends from the line D to the line G, the author being prevented by the condition of his eyes from revising other portions, the survey of

* This conclusion does not appear to us justified upon chemical considerations. For it may be that the oxyds, sulphids, chlorids, &c., of sodium and potassium are decomposed into their elements at the temperature of the sun's atmosphere, and consequently sodium, potassium, oxygen, sulphur, chlorine, &c., may be coëxistent in the free state in the sun's atmosphere and there may be far more than enough oxygen, &c., to combine with all the potassium and sodium. It would be unsafe to argue that because oxygen is the most abundant terrestrial, it must also necessarily be the most abundant solar element, yet such is possibly the case. Moreover it is not necessarily true that all metals which are reduced from their compounds by sodium must exist in the sun's atmosphere in a free state, because the masses or absolute quantities as well as the temperatures must be taken into consideration in judging of the affinities actually controlling combination.

Mitscherlich's experiments are certainly of great interest, and in fact form the second great step in our knowledge of the constitution of the sun's atmosphere. There are few branches of science which promise more magnificent results than the spectral analysis, but few which will require more cautious reasoning or more guarded and careful experiments. W. G.

which was complete. The solar lines are, for convenience, represented upon the charts together with the chemical lines, as we may term them, the author giving all the most characteristic lines presented by iron, cobalt, nickel, zinc, cadmium, gold, silver, arsenic, antimony, tin, bismuth, lead, copper, potassium, sodium, barium, strontium, calcium, magnesium, aluminum, cæsium and rubidium, at least those which lie between the lines D and G. While the charts are very admirable and reliable, they still leave much to be desired in a chemical point of view and for the purposes of analysis, because a separate chart is needed for the spectrum of each element to give a clear view of its optical characteristics. The author does not state in what manner the elements were obtained in the state of absolute chemical purity required by the peculiar nature of the problems to be solved, nor have we the guarantee of Bunsen's name and authority upon this most important point. Kirchhoff's apparatus consisted essentially of four flint glass prisms, three of which had refracting angles of 45°, the fourth an angle of 60°; the edges of the prisms could be made vertical by means of screws; a condensing and an observing telescope completed the instrument. The distances of the lines were measured by means of a micrometer screw by which the observing telescope was moved. The map of the spectrum is accompanied by a millimeter scale with an arbitrary initial point; this renders the identification of the lines easy. The map represents the spectrum as seen when the sun's altitude is great, and the author has not inserted the lines due to atmospheric absorption, though he frequently observed their great beauty especially in the neighborhood of D. For the production of metallic spectra the author employed almost exclusively the electric spark, in consequence of the great intensity of the light: a Ruhmkorff's coil was found advantageous, in some cases the lines have a measurable breadth and such cases are noted by a bracket in the drawing. The bright lines due to the passage of the spark through the air were not very perceptible; the author has represented of these only a group in the yellow and one in the green, but the brightest of the metallic lines are represented. In some cases the author observed coincidences of position in the lines of different metals: he suggests that these may be only apparent and that separation might be effected by a greater number of prisms, but it seems to us equally probable that the metals examined may not have been absolutely pure. The position of the maxima of light in the spectrum of any metal does not depend on the temperature, the presence of other vapors, or upon any condition other than the chemical nature of the vapor itself. On the other hand the relative intensity of the different maxima depends not only on the temperature but upon the changes in the mass of the vapor, so that the appearance of the spectrum at different temperatures may be very different. The inversion of the bright lines in metallic spectra produced by passing an intense light through the flame containing the metallic vapor is now a familiar fact. The author refers this fact to a general physical principle, namely, that for every species of ray the ratio between the power of radiation and the power of absorption is equal for all bodies at the same temperature. The mathematical demonstration of this principle forms an appendix to the second edition of the memoir. From this principle it immediately follows that an ignited gas, in whose spectrum

certain colors are wanting which are present in the spectrum of another body at the same temperature, is perfectly transparent for rays of these colors, and that it exerts upon rays of any color present in its spectrum an absorption which is powerful in its proportion to the brightness of this color in its own spectrum. It also follows that when the source of light which produces a continuous spectrum by which the spectrum of an ignited gas is inverted, is an ignited body, its temperature must be higher than that of the ignited gas.

The application of these principles to the determination of the chemical constitution of the sun's atmosphere is well known. The author calculates the probability that the coincidence of 60 iron lines with 60 dark lines of the spectrum is simply accidental to be less than $(\frac{1}{2})^{60}$, that is, $\frac{1}{1.000.000.000.000.000.000}$. He considers the existence of iron, chromium, nickel, calcium, magnesium, and sodium in the sun's atmosphere to be clearly proved. Barium, copper and zinc appear to be present in small quantity. Gold, silver, mercury, aluminum, cadmium, tin, lead, antimony, arsenic, strontium, lithium, and silicon could not be detected. Kirchhoff considers that the most probable assumption which we can make as to the physical constitution of the sun is that the body consists of an intensely ignited solid or fluid core surrounded by an atmosphere of somewhat lower temperature, a theory which is perfectly consistent with the nebular theory of Laplace. He elucidates and defends this theory at length, maintaining that it is consistent with astronomical observations. For a full statement of the author's views on this subject however we must refer to the original memoir as the argument does not well admit of condensation. W. G.

3. *Some observations of the Solar Spectrum.*—Weiss has availed himself of favorable opportunities presented by a voyage to the Ionian Isles to examine the thickening of the dark lines in the solar spectrum produced by atmospheric absorption. The thickening of the lines in the red and yellow portions of the spectrum, as well as an increase in their number, was distinctly and repeatedly observed. The author believes that his observations establish the fact that the thickening of the dark lines proceeds towards the violet end of the spectrum in each instance, precisely as in the case of hyponitric acid and chlorophyll. The instrument employed was a Soleil's spectroscope and the observations were made at sunrise and sunset, the clearness of the atmosphere being extremely favorable.—*Pogg. Ann.* cxvii, 191. W. G.

[*Note.*—We may here remark that the spectroscope promises to give important information with respect to several luminous phenomena of great interest. We mention as illustrations the aurora borealis, the zodiacal light, the colors of sunset clouds, and the light of comets. A comparison of the light of the aurora borealis, with the spectra produced by electric discharges in Geissler's tubes filled with rarefied air, oxygen, and nitrogen would be of great interest as confirming the electric origin of this phenomenon. If the zodiacal light be due to a ring of nebulous matter around the sun or around the earth it should exhibit lines corresponding to the vapors which it contains. A careful study of the colors of clouds at sunrise and sunset may explain the appearance of particular

lines in the spectrum itself. Sufficient light may in all these cases be obtained by the use of a condensing lens. The spectra of several fixed stars have recently been studied by a zealous amateur astronomer in the city of New York, provided with excellent instruments, and we hope soon to lay his results before the public.] W. G.

4. *On the Blue Lithium line.*—FRANKLAND, in a letter to TYNDALL, describes a magnificent blue line in the spectrum of lithium. This line does not appear when an ordinary Bunsen's burner is employed but is seen, although faintly, when a hydrogen flame is used, and becomes very brilliant when the lithium salt is heated in the oxyhydrogen flame. From this it appears that a very high temperature is necessary to bring out the blue line distinctly. Kirchhoff has already directed attention to the fact, that the appearance of the spectrum may be greatly altered by an increase of temperature, the characteristic spectrum still remaining unchanged.—*Journ. für prakt. Chemie*, lxxxvi, p. 255.

5. *On the projection of the colored rays of Metallic Spectra.*—DEBRAY has given some interesting notes on the projection of spectra by employing the oxyhydrogen blowpipe instead of the common Bunsen's burner. The author first describes a convenient form of the lime-light suitable for the projection of optical phenomena generally and then gives some details of apparatus and processes for the preparation of hydrogen and oxygen gases. When the oxyhydrogen flame is employed to heat metallic salts in projecting spectra, it is found that, as already remarked by Kirchhoff, Frankland and Tyndall, new brilliant rays often make their appearance, due to the influence of the high temperature employed. In this manner potash salts give four new triple rays of great distinctness, the first near the line D, the others from the green to the blue. The red potassium line is also distinctly doubled. Copper and lead are remarkable for the number of their rays and for the intensity and extent of the violet portions of their spectra. The author found the flame-spectre essentially identical with those obtained by means of the electric spark. This result had also been obtained by Bunsen and Kirchhoff.—*Ann. de Chemie et de Physique*, lxv, 331. W. G.

CHEMISTRY.—

6. *Lithium and Strontium in a Meteorite.*—ENGELBACH has detected lithium and strontium in a meteoric stone from the Cape. The stone was digested with fuming chlorhydric acid; the liquid evaporated gave a strong sodium reaction, showed the lines Kα and Liα faintly, a complete Calcium spectrum and, though faintly, the strontium lines α, β and γ.—*Pogg. Ann.* cxvi, 512. W. G.

[*Note.*—As strong chlorhydric acid acts directly upon glass, is it not possible that the alkalies in the solution may have been derived from the glass bottle in which the acid was kept? The excessive delicacy of the spectral analysis requires the most careful examination of the purity of the reagents employed.—W. G.]

7. *On the presence of Rubidium in certain plants.*—GRANDEAU has discovered rubidium in the ashes of the beet, in tobacco, coffee, tea, and raw tartar. The author believes that this metal is one of the more widely distributed elements and that its presence is not necessarily associated with that of lithium, as might be supposed from the analyses of minerals and mineral waters.—*Compt. Rendus*, liv, 1057. W. G.

8. *On a presumed conversion of Phenylic into Rosalic acid, and some applications of this acid and compounds in the production of various colors on Wool and Silk;* by BALTHAN BINDER. (Communicated by the author).—Experimenting with some of the bases contained in coal-tar, and more especially in an endeavor to procure decomposition of phenylic acid into benzole, I obtained the following results, which I deem sufficiently interesting and new to communicate. To decompose the phenylic acid as above, I proposed to bring sulpho-phenylic acid into contact with hydrogen in its nascent state, as follows: to the acid placed in a retort, to which a receiver was connected with an intervening refrigerator, was added a quantity of granulated zinc; reaction was engendered by gradually raising the temperature in the retort to 30°, 60°, 90°, 120°, 150° Centigrade, until reaction ceased, after ten hours; reaction was active with disengagement of sulphurous acid, hydrogen and sulphureted hydrogen. Compared to the quantity of sulpho-phenylic acid employed, but a small quantity of a colorless oily liquid, with some water, condensed in the receiver, and this, in lieu of benzole, had all the properties of phenylic acid. In the retort remained a black resinous-looking substance, which while warm was emptied into a digester, a solution of sulphuret of barium in excess added and the temperature raised to boiling. The solution, at first dirty-looking, assumed a brilliant rose color, a disengagement of sulphureted hydrogen taking place with a precipitate of sulphate of baryta and sulphuret of zinc and an insoluble organic substance. The solution after filtering and slight oversaturation with acetic or muriatic acid precipitates a flocculent orange-colored substance, which when heated cakes to a resinous looking body, with slight metallic reflection. This was further purified by re-dissolving with hydrate of baryta (other alkalies will of course serve the same purpose) in water and re-precipitated. It dissolves readily in alcohol or wood-naphtha, slightly in cold, more in boiling water; when purified and dried, is of a bright dark amorphous look, with slight greenish metallic lustre; its powder is of a dark red shade, in thin layers of an orange red when viewed with transmitted light; its watery solutions tinge wool and silk of a bright orange color, and the shades thus obtained being saturated with various alkalies, will produce orange-red, purplish-red to crimson shades, of very handsome grades. While this salt directly applied will not dye fast colors, to judge from the chemical properties of this substance, I believe it to be identical with rosalic acid, or at least a modification of it.

June 29, 1862.

9. *On the transformation of Phenate into Rosalate of Lime;* by B. BINDER. (Communicated by the author).—Referring to my former article, on the presumed conversion of phenylic into rosalic acid, I have since observed that phenate of lime placed over concentrated (not fuming) sulphuric acid in a confined space (under a bell glass) for the space of five or six months, will be largely coverted into rosalate of lime, while in free air no trace of such change is observed. The salts thus formed are readily separated by diluting with warm water, and saturating the lime with hydrochloric acid, when the phenylic acid will rise to the surface, while the rosalic acid precipitates. The first can be decanted from the muriate of lime, the remainder filtered, the latter will remain on the

filter, and can then be purified by proper treatment, when it will have all the chemical properties mentioned in my former article of what I presumed to be rosalic acid obtained from the treatment of phenylic acid.

Tacony Chem. Laboratory, (Bridesburg,) Philadelphia, Aug. 7, 1862.

10. *Thallium.*—Crookes has sent us an early copy of his "*Preliminary researches on Thallium*" from the Proceedings of the Royal Society. Crookes' discovery of this new metallic element was published March, 1861, and therefore completely antedates the paper of Lamy, an abstract of which is given on page 275–6 of this volume. The name *Thallium*, is derived from the Greek θαλλὸς, or Latin *thallus*, a budding twig,—a word which is frequently employed to express the beautiful green tint of young vegetation, chosen on account of the green line which it communicates to the spectrum, recalling with peculiar vividness the fresh color of early spring.

It appears from Crookes' researches that thallium is by no means a very rare substance; he has found it in many mineral ores from various localities. It was present in more than one eighth of the specimens in a large collection of cupiferous pyrites from different parts of the world—he has rarely found it however in pyrites in which copper was absent. In most cases it is only necessary to powder a small fragment of the mineral and ignite a little of it in the flame on a moistened platinum wire, when the green line is distinctly seen in the spectroscope. The author thinks that in some of the large English copper, sulphur and sulphuric acid works, thallium is now thrown away by the hundred weight: a slight modification of the present arrangements of the furnaces and condensing flues, or even an examination of some of the residues, would enable nearly the whole of this to be saved. Owing to the frequent occurrence of thallium in copper ores it is very probable that this element may sometimes be present in commercial copper and may give rise to some of the well known but unexplained differences of quality.

The author finds the following the most advantageous method for extracting the new element from sulphur or pyrites:—

Powder the ore very finely, and dissolve it as completely as possible in strong hydrochloric acid, with gradual addition of nitric acid until all solvent action ceases; then dilute with water, and filter. Evaporate down to drive off the excess of nitric acid, add a little sulphuric acid if necessary, and take care that the solution does not get dry, or even pasty. Then dilute with water, and heat gently, to be certain of getting all the soluble portion dissolved. Filter: if lead be present, the greater portion will be left behind in this operation in the form of insoluble sulphate. Dilute the filtrate considerably, and add a solution of carbonate of soda until the reaction is distinctly alkaline; then add an excess of solution of cyanid of potassium (free from sulphid of potassium). Heat gently for some time, and then filter. The precipitate contains the whole of the lead and bismuth which may be present as carbonates, whilst the thallium is in solution. A current of sulphuretted hydrogen now being passed through the liquid precipitates all the thallium, whilst the copper, antimony, tin, and arsenic remain dissolved. If cadmium and mercury are present, they will accompany the thallium. The former can readily be dissolved out by warm dilute sulphuric acid, which has scarcely any solvent action on the sulphid of thallium, whilst this in its turn can be separated from the sulphid of mercury by being boiled in moderately dilute nitric acid, in which the sulphid of mercury is insoluble. These two metals are, however,

seldom present with thallium in the ores which I have examined. The nitric acid solution is now to be evaporated to dryness, the residue dissolved in hot dilute sulphuric acid, and a piece of pure metallic zinc placed in the liquid; the thallium will be at once precipitated in the form of a deep-brown powder, which soon changes to a heavy black, granular precipitate. The metal can be obtained in the coherent form by fusion in hydrogen.

This method of analysis is given on the supposition that all the above metals are present. It may generally be much abridged, as the ore is seldom of so complicated a character. If there is a difficulty in procuring perfectly pure zinc for the reduction of the sulphate to the metallic state, this can be effected by passing a weak voltaic current through the liquid, using platinum poles; the metal will then be precipitated in the reguline, or spongy state, according to the strength of the current. I have not been very successful in reducing the oxyd by hydrogen. The current of gas carries the volatile oxyd away from the heated part of the tube before complete reduction takes place. It is, however, probable, from an observation made towards the conclusion of this experiment, that, with a longer tube in proportion to the quantity of material, kept at a good heat throughout its length, this plan might give good results, the metal being considerably less volatile than the oxyd.

Mr. Crookes adds the following description of thallium and its chemical reactions and compounds, which we copy in full from his paper.

Thallium in the pure state is a heavy metal, bearing a remarkable resemblance to lead in its physical properties. Its specific gravity is, however, higher—about 12. The freshly scraped surface has a brilliant metallic lustre not quite so blue in color as lead, and it tarnishes more rapidly than this latter metal. It is very soft, being readily cut with a knife and indented with the nail; it may also be hammered out and drawn into wire, but has not much tenacity in this form. It easily marks paper. The fusing point is below redness, and with care several pieces may be melted together and cast into one lump. There is, however generally a loss in this operation, owing to its rapid oxydation. The metal itself does not appear to be sensibly volatile below a red heat. I have made no special attempts at present to determine the atomic weight, although from two estimations of the amount of sulphur in the sulphid it appears to be very heavy. The figures obtained did not, however, agree well enough to enable me to speak more definitely on this point, than that I believe it to be above 100. I may mention that I obtained this element in the pure metallic state and exhibited it to several friends as early as January last,* and should then have published an account of it, had it not been for the reasons already mentioned. Thallium is soluble in nitric, hydrochloric, and sulphuric acids, the former attacking it with greatest energy, with evolution of red vapors.

Oxyds of Thallium.—Thallium forms two, and probably three oxyds: one possessing basic properties, which I shall call the oxyd; another containing more oxygen, possessing acid properties, which may therefore be called thallic acid; and most likely a third, or suboxyd, which forms the first portions of the precipitate formed by zinc in solutions of this metal; the first action being a darkening of the solution, and the production of a deep-brown powder, which by longer contact with zinc turns to a dense black precipitate.

Upon carefully evaporating the nitric acid solution upon a water bath, but not carrying it to dryness, a mass of deliquescent crystals is obtained on cooling, which are decomposed upon addition of water with separation of a white or pale-yellow precipitate, which appears to be a subnitrate, and an acid solution containing nitrate of thallium. If the liquid is evaporated quite to dryness and kept at a temperature of 100° C. for a little time, the nitric acid goes off, and leaves a residue of thallic acid.

* Vide Chemical News, vol. v, pp. 349, 350.

Thallic Acid.—This acid is soluble in water, and may be obtained in the crystalline form from its aqueous solution. It then forms crystals, which are permanent in the air, and have an acid reaction to test-paper. The thallates of the alkalies are also soluble in water, and may be prepared by dissolving the acid in the alkali, or by fusing thallium or its oxyd with a mixture of alkaline carbonate and nitrate. The method I originally published for extracting thallium was based upon the formation in this manner of an alkaline thallate soluble in water. This acid is also produced in solution when permanganate of potash is added to a soluble salt of oxyd of thallium.

Chlorid of Thallium.—If a current of dry chlorine is passed over precipitated thallium at a moderate heat, they combine with formation of a volatile chlorid, which condenses in the cool part of the tube in the form of a pale-yellow crystalline powder, fusing together in parts to a crystalline lump. Water only partially dissolves this, with production of a white insoluble residue. Dilute hydrochloric acid added to the turbid solution immediately renders it clear; upon evaporating this solution over a water-bath, white crystals of the chlorid are deposited. When the nitric acid solution of thallium or its sulphid is evaporated with an excess of hydrochloric acid, and then more hydrochloric acid added and the evaporation repeated to a syrup, a residue is obtained which is apparently decomposed by water with production of a white precipitate: this is chlorid of thallium; it is insoluble or nearly so in water, but readily soluble in dilute hydrochloric or nitric acid.

Sulphid of Thallium.—When sulphuretted hydrogen is passed through the acid solution of chlorid of thallium, a partial precipitation of a reddish-brown powder takes place; this appears to be a combination of the chlorid and sulphid, and the metal is never entirely removed from solution by this means. The best method of obtaining the sulphid is to precipitate it with sulphid of ammonium in an alkaline solution; unless a large quantity of thallium is present, no immediate effect is produced beyond the darkening of the liquid; it assumes a brown tint, which becomes rapidly more and more intense, especially upon gently heating it, until the sulphid of thallium separates in the form of a deep brown heavy precipitate which shows a great tendency to collect together in clots at the bottom of the vessel: this formation of the sulphid is very characteristic of the metal. Sulphid of thallium is insoluble in an excess of sulphid of ammonium, ammonia, or cyanid of potassium. Its complete precipitation as sulphid from solutions containing an excess of cyanid of potassium affords a ready means of separating thallium from several metals with which it is frequently associated. It is difficultly soluble in hydrochloric or sulphuric acids, but readily so in nitric acid. When dry, it is a deep-brown, almost black powder, fusing and volatilizing when heated: when pure, it is neither so fusible nor so volatile as sulphur; but when it occurs with an excess of this lattter element, it is very difficult to separate from it by sublimation.

Carbonate of Thallium is precipitated upon adding an alkaline carbonate to the acid chlorid solution; it is moderately soluble in an excess of carbonate of ammonia, and readily so in cyanid of potassium. This is a very definite reaction, and enables thallium to be separated with accuracy from lead and bismuth.

Sulphate of Thallium.—When the hydrochloric or nitric solution is evaporated down with sulphuric acid, the more volatile acid is driven off and the sulphate is left behind. It is crystalline and soluble in water.

Iodid of Thallium is precipitated as a yellowish-red powder upon cautious addition of iodid of potassium to a solution of thallium. It is readily soluble in excess of iodid of potassium, forming a colorless solution.

Phosphate of Thallium forms a white flocculent precipitate soluble in mineral acids, but sparingly soluble in acetic acid.

Ferrocyanid of Thallium is white and insoluble in water.

Cyanid of Thallium is precipitated as a white or light-brown powder upon the cautious addition of cyanid of potassium to a solution of thallium. It is readily soluble in an excess of the precipitant.

Chromate of Thallium is a pale-yellow precipitate soluble in acids and re-precipitated upon neutralization with ammonia.

No precipitates are produced when a solution of thallium is mixed with *protochlorid of tin, oxalic acid, carbazotic acid, sulphurous acid,* or *protosulphate of iron.*

The reactions are sufficient to prove chemically that the body under examination is a new element. Its behavior in the spectrum apparatus is perhaps the most conclusive test upon this point. When a minute portion of the metal (the sulphid, chlorid, or in fact, any compound of thallium) is introduced into the flame of the spectroscope, it immediately produces a single green line, perfectly sharp and well defined upon a black ground, and of extraordinary purity and intensity, almost equal to the sodium-line in brilliancy. It is not, however, very lasting. Owing to its great volatility, a portion introduced at once into the flame merely shows the line as a brilliant flash, remaining only a fraction of a second; but if it be introduced into the flame gradually, the line continues present for a much longer time. If, also, a piece of metallic thallium be introduced into the flame on a platinum wire loop, they fuse together, and the alloy gives the green line rather more permanently, although of course fainter.

Working on a small scale, it is not easy to obtain these compounds free from soda; but when that is effected, and a tolerable quantity of substance is held on a loop of platinum wire in a flame, the green color is most brilliant, and produces very extraordinary effects upon the appearance of surrounding objects. If thallium could be obtained in quantity, this ready means of producing an intense and homogeneous green light could not fail to be applicable to some useful purpose.

The green line of the thallium spectrum appears to be unaccompanied by any line or band in other parts of the spectrum. A flame of sufficient temperature to bring the orange line of lithium into view produces no addition to the one thallium-line; and an application of telescopic power strong enough to separate the two sodium-lines a considerable distance apart still shows the thallium-line single. I consider therefore that I am justified in stating that thallium produces *the simplest spectrum of any known element.* Theoretical inquiries into the cause of the spectrum lines, and their relation to other constants of an element, may be facilitated now we know a metal which gives rise to luminous vibrations of only one degree of refrangibility. The remarkable simplicity of the thallium spectrum offers a strong contrast to the complicated spectra given by mercury, bismuth, and lead—the metals to which it has the most chemical resemblance.

The position of the green line does not coincide with any definite line in the solar spectrum. According to Kirchhoff's theory, we must therefore assume that thallium is not present to any great extent in the sun. Under the highest telescopic power of my apparatus, the line appears to be absolutely identical in refrangibility with a sharp well-defined line in the barium spectrum, to which Professors Bunsen and Kirchhoff have given the name Baδ. Want of material has hitherto prevented me from

taking accurate measurements of the distance between the thallium-line and the principal lines of the solar spectrum.

This green line is an exquisitely delicate test for the presence of thallium, and shows it to be a somewhat widely distributed element. Many specimens of crude sulphur contain it (especially when rather dark-looking). In most cases it is only necessary to set fire to as large a piece of sulphur (less than a pea) as the platinium loop will hold, and when it has nearly burned away to blow it out, and then introduce it at leisure into the flame of the spectroscope, for the thallium to show its presence by a bright-green line which will flash for an instant into the field of view.

TECHNICAL CHEMISTRY.—

11. *For Photographic copying in pure Black and White.*—In copying maps, printed matter, engravings, &c., the following will be found an excellent method. After fixing a delicate negative, wash *very carefully*. Then flood with a solution of free iodine in iodid of potassium, two grains of the iodid to one grain of the iodine in the ounce of water. Dilute with water to a sherry pale color, or dark, as may be found necessary. Wash well and fix. Repeat the process, if necessary. The intensity of the color in the solution is a measure of the amount of iodine available. The liquid becomes colorless, by degrees; go on until it is quite colorless. To intensify, use Russell's developer for the tannin process, until experience shows you have sufficient intensity. Now immerse totally in bichlorid of mercury in acidulated water. One drop of nitric acid to six ounces of water. Wash very thoroughly. Flood with weak iodid of potassium, adding gradually to its strength until the deepest yellow with a tinge of olive color is obtained by transmitted light. Wash again, and treat with chlorid of gold, one grain to the ounce of water. E.

II. GEOLOGY.

1. *Observations on the Appalachian region of Southern Virginia;* by J. P. LESLEY (from an account of the Coal formation of Southern Virginia, in the Proc. Amer. Phil. Soc., Jan., 1862).—The coal region of Montgomery, Pulaski, Wythe, Washington, and Smith counties in Southern Virginia, is interesting in an economical as well as a geological sense. It furnishes species of semi-anthracite and semi-bituminous coal, which come in competition with the Mesozoic bituminous coal of the Richmond basin, over the principal internal railroad of the Southern Atlantic States. This railroad penetrates the great primary range of mountains, the Blue Ridge, at Lynchburg, and then follows the course of the Great Valley, southwestward, to Knoxville and Chattanooga, in Eastern Tennessee. This Great Valley, of Lower Silurian limestone, extends from Newberg on the Hudson to Montgomery in Alabama, everywhere separating the range of the Blue Rridge, South Mountain, Smoky Mountain, or Black Hills, from the true Alleghanies or Appalachians. The rocks of the Blue Ridge range, on the eastern side of the Valley, are a prolongation of the Green Mountains of Vermont, and consist of the Quebec group or Taconic system, now understood by Logan to be a thickening of the lowest Silurian (Calciferous Sandrock and Potsdam Sandstone or Primal

Slates).* The Appalachian Mountains on its western side are Middle and Upper Silurian and Devonian formations. West of these rises the long high escarpment of the Carboniferous formation, forming the mountain plateau of Western Pennsylvania, Western Virginia, Eastern Kentucky, Central Tennessee, and Northern Alabama. The escarpment of this vast plateau, facing the east, and overlooking the Appalachian ranges, with their narrow, parallel, interval valleys, is the so-called Backbone Alleghany Mountain, beginning at Catskill on the Hudson, and ending in Alabama. The northern portion of this plateau is drained eastward by the branches of the Susquehanna, and westward by the branches of the Alleghany and Monongahela Rivers. All the waters of Middle Pennsylvani, Maryland, and Northern and Middle Virginia flow from the foot of this escarpment towards the Atlantic, breaking successively through the parallel Appalachian ridges of the subcarboniferous formations. The waters of the Tennessee River head also at the eastern foot of this escarpment, and flow along its base for several hundred miles southwestward, before they turn west at Chattanooga, and break through its southern extremity, to make their great circuit through Alabama, Western Tennessee, and Kentucky to the Ohio River near its mouth. But in the middle of the region, namely, in Southern Virginia, its normal drainage is reversed. The New River heads in the Blue Range, crosses the Great Valley westward, breaks *into* (not *out of*) the Appalachians, striking the escarpment in its face, and flowing directly through and across it (as the Great Kanawha) through Western Virginia into the Ohio.

The cause of this phenomenon is to be found in a change of structure at this line. Most of the valleys and mountains north of it as far as New Jersey are unbroken anticlinals and synclinals. Most of the valleys and mountains to the south of it, as far as Alabama, are monoclinals, bounded by immense faults or downthrows.

The Appalachian Mountains of Southern Virginia and Eastern Tennessee are grouped in pairs by these faults. The country for three or four hundred miles northeast and southwest, and from thirty to forty miles from southeast to northwest, is fractured in parallel strips from five to six miles wide. Each strip is tilted at such an angle (dipping southeast) that at each fault the upper edge of one strip (with its Carboniferous rocks) abuts against the bottom or Lower Silurian edge of the strip next to it. As the Palæozoic system, thus revealed (on edge) between any two of these faults, contains two massive sandrock formations, No. IV, Middle Silurian, and No. X, Upper Devonian, there occur necessarily between each pair of faults a pair of parallel moutains. The Palæozoic zone, therefore, included between the Great Valley and the Backbone escarpment, is occupied by as many pairs of parallel mountains as there are great parallel faults: and as these faults range in straight lines at nearly equal distances from each other, these mountains run with remarkable uniformity, side by side, for a hundred or two hundred miles, and are finally cut off, either by short cross faults, or by slight angular changes in the courses of the great faults. Thus we get an explanation of the

* It is but just, to say that the Professors Rogers maintained substantially this view before 1840, considering, as they did, the Blue Ridge System an enlargement merely of Formation No. I.

very unusual arrangement of the head waters of the Tennessee River, in long parallel branches, with few subordinate affluents, suddenly uniting through mountain gorges, or at the ends of long mountains.

In each pair of Palæozoic mountains the eastern one carries a coal area on its seaward flank; because, the last formation to dip against each fault is the Coal at the top of the series, abutting against the Lower Silurian of the limestone valley which always exists on the eastern side of the fault.

The coal here, however, is not the coal of the Carboniferous formation, commonly so called.

Underneath the true coal measures of Pennsylvania, Ohio, and Northwestern Virginia, and underneath the Millstone Grit Conglomerate (No. XII) at its base, and the Red Shale formation (No. XI), which underlies the last, there begins, even in Pennsylvania, to appear an older coal formation, connected with the uppermost Devonian, white, mountain Sandstone, No. X. It is seen in one or two beds two feet thick at the head waters of the Juniata. It is mined where the Monongahela waters cut through Chestnut Ridge from Virginia into Western Pennsylvania. It has been mined in the mountains on the Potomac *below* Cumberland. It appears occasionally in Northern Middle Virginia, on the western side of the Great Valley of Winchester. It increases in importance along the western outcrop of the great coal field through Eastern Kentucky, until it enters Tennessee. It seems, however, to obtain its maximum development in Montgomery county, on the New River, in Southern Virginia, near the line of our section. Here it is seen to consist of two principal coal-beds and several minor seams. The lowest bed reaches the thickness of four feet, and the next one above it is in some places nine feet thick. In the Peak Hills, just east of Wythe, along the line of the railroad, numerous lenticular deposits of coal are seen, and thin distorted beds, the whole composing a formation several hundred feet thick. Near the New River, the two beds above-mentioned are seen to be covered by at least a thousand feet of Red Shale; upon which rests a Subcarboniferous limestone; which abuts, at the fault, against other limestones belonging to the Lower Silurian age. Between Christiansburg and Blacktown, north of New River, a regular synclinal coal-basin has been preserved for a few miles upon the eastern side of the great fault, which crosses the river in front of the gap. In this coal-basin the two beds of coal are preserved, but in a crushed condition. To the southwest, two faults cut off a similar short basin from the regular coal formation on the mountain, throwing up a wedge of Lower Silurian Limestone.

It is here that the relationship of these great faults to the normal anticlinals and synclinals of the Appalachian region can be studied to great advantage; the presence of cross faults at high angles being exhibited by the sudden termination of the mountains, and by the tearing open, as it were, of one side of anticlinal coves.

2. *Dyas, order die Zechstein formation und das Rothliegende*, von Dr. Hanns Bruno Geinitz, Director des Kön. Min. Mus., und Professor an der Polytech. Schule zu Dresden, etc., mit Beiträgen der Heeren Robert Eisel, Rudolph Ludwig, Dr. August Em. Reuss, Der Reinhard Richter u. A. Heft. II, Der Pflanzen der Dyas und Geologisches. 210 pp. 4to,

with 19 lithographic plates.—This volume is the concluding part of the great work on the Permian, noticed in the September number of this Journal. It contains an account of the Fossil botany of the Permian, illustrated by 11 quarto plates; and following this, descriptions of the Permian formation in Saxony, Silesia, Bohemia, Thuringia, Western Germany, Russia and other parts of Europe, and Great Britain. An Appendix includes an Index Plantarum and a long table showing the geological and geographical distribution of the Permian in Europe. This work of Dr. Geinitz should be in the hands of all who would understand the Geology of the Permian period,—a period having a special interest from its relations to both the Palæozoic and Mesozoic eras. While essentially belonging with the former, it is the transition period between the two. The recent discovery of Permian beds west of the Mississippi renders the work of additional interest to American geologists.

3. *On the footprints of Limulus as compared with the Protichnites of the Potsdam Sandstone;* by J. W. Dawson, (Canadian Naturalist).—In this paper Mr. Dawson compares the impressions called *Protichnites* (see Jour. Geol. Soc. London, vol. viii) with the tracks of a modern Limulus, illustrating the subject with figures. The following are his conclusions with regard to these Potsdam impressions:—

"(1.) The conjecture of Owen that they may have been made by a creature somewhat resembling Limulus, is verified by the impressions made by that animal.

(2.) The further view of Owen that the grouping of the impressions depended on multifid limbs, and that the number of impressions in a group might indicate specific diversity, is also vindicated by the facts, with this limitation, anticipated by Prof. Owen, that tracks like *P. lineatus*, might have been made by any of the animals which made the other impressions, and that if like Limulus they possessed one large pair of feet making the principal marks, and smaller ones occasionally used, the numbers of marks may have somewhat differed in different circumstances. Still it is evident that a species of Limulus having a different number of divisions of the posterior toes, from that to which these remarks relate, might be distinguished by its footprints.

(3.) The animal or animals producing the Protichnites probably resembled Limulus in general form, and in the possession of a strong caudal spine. They probably differed from Limulus in the less breadth or depth of the cephalo-thorax, and in the greater complexity and comparative size of the feet.

(4.) Some at least of the Protichnites were probably produced by animals creeping on wet sand; but *P. lineatus* and the *Climactichnites*, if the work of a similar animal, were formed under water. This accords with the view entertained by Sir W. E. Logan as to the conditions of deposition of the Potsdam sandstone; and it is probable that these ancient Crustaceans, like the modern Limulus, frequented the sandy beach for the purpose of spawning, and may sometimes have been left dry by the tide.

(5.) The suppositions above stated would account for the absence or rarity of remains of the animals which produced the Protichnites. It is rare to find on the modern beach any fragment of an adult Limulus,

except on the dry sand above high-water mark. The creatures are driven on shore only in storms, and then, owing to the lightness of their crusts, are drifted high on the beach. The remains are probably to be found in circumstances favorable to their preservation, only on the muddy bottoms at a distance from the sandy shore. Young individuals appear to frequent the sand only in summer, and occasionally to be imbedded in it.

(6.) If we inquire what animals, known to palæontologists, have produced the Protichnites, it would seem that no others fulfill the necessary conditions in any particular, except the larger trilobites, for instance those of the genus *Paradoxides*. It is true that we know nothing as yet of the feet of these creatures, but it seems almost certain from analogy that they must have possessed such organs. Nor have these trilobites a caudal spine like that of Limulus; but here again Mr. Billings points out to me that the pygidium of Paradoxides is narrow and spine-like, though I should think not sufficiently so to form the very distinct median groove of Protichnites, unless indeed the animal was in the habit of walking with this organ pointed downward. On the whole we may safely conclude that if any of the larger Primordial trilobites were provided with walking and swimming feet of the type of those of Limulus, but differing in details of structure, they may have produced both the Protichnites and the Climactichnites. On the other hand, it is quite probable that these impressions have been formed by Crustaceans yet undiscovered, and approaching in some respects more nearly to Limulus than any of the known trilobites. In this last case I should suppose that the animal in question had a flatter or more shallow cephalo-thorax than that of Limulus, proportionately stronger and perhaps more divided feet, and a stouter caudal spine.

It is scarcely necessary to observe that the footprints of Limulus differ materially from those of the higher Crustaceans, and also from the galleries formed by many small burrowing Crustaceans. With these last Mr. T. Rupert Jones, in an interesting article in the "Geologist" for April, seems disposed to compare *Climactichnites Wilsonii;* but this appears to me to have more the character of a surface impression, though what appear to be galleries of small Crustaceans are also found in the Potsdam sandstone. The '*Nereites*' of Emmons,* from the Taconic rocks of that author, also resemble in some respects the sub-aquatic trails of Limulus, and may be the work of Trilobites; and the same remark applies to some of the markings from the Clinton of New York, figured by Hall,† and referred to Crustaceans and worms."

Note.—It appears very improbable that the fossil Paradoxides, like other Trilobites, would be so uniformly deprived of stout limbs, if the living animal had them; for limbs that could make the very large tracks of the *Protichnites*, would hardly fail to become fossilized. The reference of the *Chimactichnites* tracks to the Paradoxides is in all probability right. The same opinion is expressed by the writer in his Manual of Geology in a paragraph printed six months since, though the work is but just now leaving the press. J. D. D.

* Agriculture of New York, vol. i.

† Palæontology of New York, vol. ii, Pl. 13 to 16.

4. *Fifteenth Annual Report of the Regents of the University of the State of New York on the condition of the State Cabinet of Natural History, &c.*, made to the Legislature April 12, 1862; 8vo, pp. 170. Albany: C. Van Benthuysen, 1862.—This Report contains the continuation of Prof. Hall's Palæontological researches. The larger part of the memoir has been already noticed briefly in former issues of this Journal, vol. xxxii, 430, Nov., 1861, and in this volume, p. 282. It is enriched by numerous figures in the text and by eleven plates of fossils, two of them on stone. One of the latter is a reproduction of a plate of Mr. Conrad's to vindicate himself and Mr. C. from the criticisms made by Mr. Billings of the Canadian Survey, upon the genera *Cypricardites* and *Modiolopsis*.

The last page of the report contains a letter from Col. E. Jewett, Curator of the State Cabinet, announcing an important observation made by that gentleman on the age of the "Catskill group." The same information has been communicated to us in a letter from Col. Jewett, but we copy from the official document as follows:

"Albany, September 20, 1862.

Dr. S. B. Woolworth, *Secretary of Regents*, &c.—Sir:—Agreeable to your directions, I went to Delaware county, to collect fossils from the Catskill group, or Old Red Sandstone.

At Franklin I found Mr. J. M. Way, a gentleman who for years has been examining the rock and collecting the fossils; and although he is unacquainted with any other localities, and has never seen a collection of fossils, he has succeeded in investigating the whole strata of the neighborhood and collecting many fossils. With his assistance, I was able to make a section from the Oleout creek to the top of a hill about three miles southwest of the village of Franklin, more than 800 feet in thickness. The base is a brick red shale, with occasional red argillaceous sandstone, about 400 feet. On this is about fifty feet of greenish shale; on which lies a stratum of gray sandstone, with teeth and plates of fishes, and fossils of the *Chemung group*. Seventy feet of green shale lie on this fossiliferous stratum; when another thin band of fossils, with gravel and the same formation, continues with alternate shale and gray sandstone and fossils to the top of the hill, where the Chemung fossils are more numerous. Spirifers, Rhynconellas, Pectens and Athyres are found in all the strata of the upper three hundred feet, and the whole formation is undoubtedly Chemung.

I examined other localities with the same result.

Mr. Way has examined the rock as far as Deposite (twenty-five miles southwest), with great care, and finds the same formation. He has also collected the same fossils at Delhi, seventeen miles southwest.

From my investigations, I believe that there is no Old Red Sandstone [Catskill formation] in this State. * * *

* * * * * * *

Respectfully, &c.

E. Jewett."

III. BOTANY AND ZOOLOGY.

1. *Dimorphism in the Genitalia of Flowers.*—Two principal kinds of this dimorphism have been noticed in a great number of instances, and put on record in various works; but the instances have not been collected and systematized, nor had the import of the most curious case been made out until it was recently elucidated by Mr. Darwin. There is, first, the dimorphism which Mr. Darwin has recently illustrated in his paper "On the two forms, or Dimorphic Condition, in the species of *Primula*," which was briefly noticed in the preceding number of this Journal (p. 285). This was here long ago named *diœcio-dimorphism* (see Flora N. America, ii, p. 38, etc.); a name which pretty well expresses the thing, as now understood, for these blossoms although hermaphrodite structurally are functionally as if diœcious, or nearly so, the end subserved being fertilization of the ovules of one flower by the pollen of another flower on another individual.

The diœcio-dimorphous species of *Plantago* had seemed to confuse this case with the next. That is, the short-stamened flowers appeared to be fertilized in the closed flower, and the long-stamened and generally sterile plants therefore to be generally useless. This could hardly be; and a recent observation on a single specimen (likely to be confirmed in others) shows the top of the style projecting from the tip of the closed corolla. This refers the case to the same category with *Houstonia*, *Primula*, &c., to which *P. prisella* and *P. heterophylla*, having the corollas of the short-stamened form open in anthers, and the stigma projecting, evidently belong. It is to be noted that dimorphism, both of this and of the following sort, is apt to be variable either in mode or in degree in different species of the same genus, and also that it seldom occurs in all the species of a genus, some of them being unaffected, while others in some genera are nearly polygamous or diœcious;—which is all very favorable to the conclusions that Mr. Darwin wishes to draw.

The second case, which equally belongs to structurally hermaphrodite flowers, is practically the reverse of the first. It is the case in which, besides the normal flowers of the species, which for the most part are rarely or sparingly fertile, other flowers are produced which never open, their development being as it were arrested in the bud, but which are very prolific of seed. Here the stigma is, and must needs be, fertilized by pollen from the anthers of the same flower, the two being shut up together in the same closed bud. The acaulescent Violets and the common wild species of *Impatiens* are good examples of the kind. In fact, here impregnation is effected as it were in the early bud;—wherefore we had indicated these as cases of *precocious fertilization*. Here the pollen is unusually active, sending out its tubes while still in the anther, and thereby in *Impatiens*, &c., attaching the anthers to the stigma. In the first case Nature takes great pains to secure the cross-fertilization of individuals of the species: in the other, on the contrary, she takes equal pains to secure self-fertilization. The end in the first case, as Mr. Darwin maintains, (we believe upon good philosophical grounds, now in the course of vindication by experiment) is to ensure the perpetuation of the species,

since close-breeding or continued self-fertilization tends to sterility, while wider breeding is recuperative. We leave it to Mr. Darwin's sagacity to ascertain the end in the opposite case, noting that here the most undoubted close-fertilization for indefinite generations shows no apparent tendency towards sterility, but rather the contrary.

From another point of view which we are accustomed to take, however, we may suppose that, as one result the cross-fertilization must needs be to keep down variation by repeated blendings, so the design of close-fertilization may be to allow and to favor the perpetuation of varieties. Self-fertilization, without selection, being just the condition which should most favor both the multiplication of new varieties and their preservation. That such would be the operation (as long ago expounded in this Journal, vols. xvii and xix) appears to us so clear, that we were somewhat surprised at finding that the reviewer of Darwin's *Primula*-paper in the Natural History Review (ii, p. 238) regards the separation of sexes, and therefore cross-fertilization, as favoring variation, and self-fertilization as necessarily inimical to it. This probably comes from not considering that while close-breeding tends to keep a given form true—in virtue of the ordinary likeness of offspring to parents—it equally and in the same way tends to perpetuate a variation once originated from that form, and also, along with selection (natural or artificial), to educe and further develope or confirm said variety. On the other hand, free cross-breeding of incipient varieties *inter se* and with their original types is just the way to blend all together, to repress all salient characteristics as fast as the mysterious process of variation originates them, and fuse the whole into a homogeneous form.

We will also remark (in reference to p. 236, line 31, and p. 238, line 3 et seq. of the above mentioned Review) that the Chestnut does exhibit manifest rudiments of stamens in its pistillate flowers; also that, on morphological grounds, we should look upon hermaphroditism, rather than the contrary, as the normal or primary condition of flowers, and enquire how and why so many became diclinous, rather than "how and why they ever became hermaphrodite." Forms which are low in the scale as respects morphological completeness may be high in the scale of rank founded on specialization of structure and functions. A. G.

2. *Fertilization of Orchids through the Agency of Insects.*—In our notice of Mr. Darwin's charming new work, in the July number of this Journal, we could not get beyond the first two chapters, relating to the *Ophrydeæ*, or the tribe to which the Orchises themselves belong. Those of our readers who, appreciating the treat to which they were invited, have been looking into our Orchideous flowers, will not be sorry to have us resume the subject.

In default of drawings from some of our own species, which we should prefer if we had them, we borrow the cuts with which the author illustrates the two British species (*Orchis mascula* and *O. pyramidalis*) with the account of which Darwin's book, and our abstracts, commenced. These figures should render those abstracts much more intelligible. The small letters denote the same thing in all the figures.

a, anther; *r*, rostellium; *s*, stigma; *l*, labellum; *n*, nectary; *p*, pollinium or pollen-mass; *c*, caudicle of pollinium; *d*, viscid disc of pollinium.

A, is a side view of a flower of *Orchis mascula*, with all the petals and sepals cut off except the labellum, of which the near half is cut away, as well as the upper portion of the near half of the nectary.

B. Front view of the flower, with all the sepals and petals removed, except the labellum.

C. One pollinium, or pollen-mass, showing the packets of pollen-grains, the caudicle, and the viscid disc.

D. Front view of the discs and caudicles of both pollinia within the rostellum, with its lip depressed.

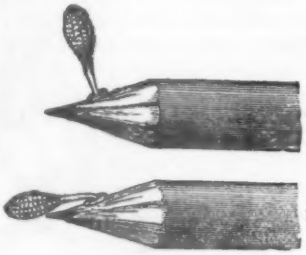
E. Section through one side of the rostellum with the included disc and caudicle of one pollinium.

F. Packets of pollen-grains, tied together by elastic threads, here extended.

The general structure of the flower in this species will be found to correspond very well with that of our *O. spectabilis*.

Now, supposing one of the pollen-masses to be removed from the flower by the insertion of the point of a pencil into the orifice of the nectary, on

withdrawing the pencil, the pollen-mass, adhering by its viscid disc, will be found to stand as represented in the accompanying figure G. But in a few seconds a movement of depression takes place, through which the pollen-mass is brought invariably into the position represented in figure H. And now, upon again inserting the point of the pencil into the orifice of the nectary, the pollen mass will be brought into contact with the glutinous stigma, to which some of the pollen-packets will certainly adhere.



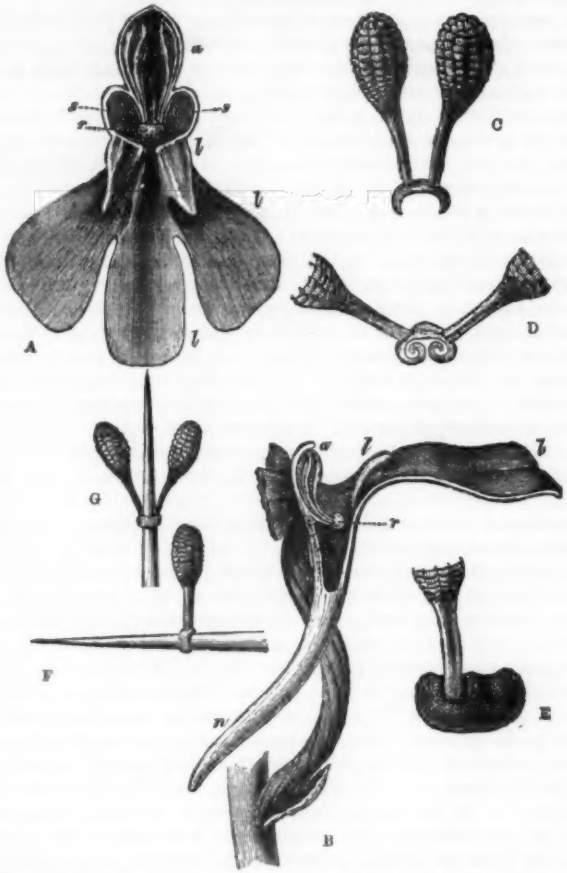
The following figures relate to *Orchis pyramidalis*, and our extracts should be read anew in connection with the illustrations. The small letters, as far as they go, indicate the same parts as in the foregoing illustrations. (See page 423.)

The egg having once been set on end, any body can do the feat, with more or less dexterity. At least every person should make observations according to his opportunity; although their interpretation will often task even Mr. Darwin's sagacity. As our present contribution, we proffer a few notes upon some of the Orchids of our district,—giving due warning, however, that our observations, made during the past summer, were so hurried and casual that they must not be too much relied upon. They may serve a purpose in directing the attention of others to the subject.

Having sufficiently described the arrangements for insect agency in the fertilization of *Platanthera Hookeri* (this volume, p. 143), we will now turn to its relative,

Platanthera orbiculata, one of our most striking species. Of this we first received some spikes in early bud,—in which state it is plain to see that the discs of the pollinia are an integral part of the stigma, their viscid surface being then continuous with that of the stigma. It may be worth mentioning that these spikes, stuck into a glass of water for eight or ten days, developed many of their flower-buds tolerably well, excepting the spur, which instead of elongating remained a scrotiform protuberance,—an 'arrest of development'—and at length sphacelated. The full-grown spur in this species being an inch and a quarter or an inch and a half long, and the divergent bases of the anther-cells so separated by the broad stigma that the viscid discs stand nearly a quarter of an inch apart, it is evident that fertilization is effected by the agency of large Lepidoptera or Hymenoptera. Self-fertilization is out of the question. Here the labellum is pendent, inviting a front approach, while the lateral petals, as is usual in this tribe, guard against a flank movement. The way in which the anterior portion of the anther-cells with the combined arms of the stigma taper and project forwards, so as to raise the discs on a sort of beak, a little in advance of the orifice of the nectary, is well exhibited in Hooker's figure of this species, in the Flora Bor. Amer.: but the discs do not look outwardly in the manner there represented. These, being affixed to the stalk of the pollen-mass laterally, by that intermediate body called the drum-like pedicel, (here developed perhaps even more than in *P. Hookeri*,) really look forward and inward—in fact are so placed that they will be sure to stick one to each side of the

head of a humble-bee or of a large moth that visits the flower, and thrusts its proboscis down into the spur so as to reach the nectar. The movements of rotation and depression in our flowering specimens (all received from a distance) were pretty slow, but distinct.



A. Front view of a flower of *Orchis pyramidalis*, with all the sepals and petals removed except the labellum.

B. Side view of the same, with the labellum longitudinally bisected, and with the near side of the upper part of the nectary cut away.

C. The two pollinia, attached to the saddle-shaped viscid disc, which answers to the two separate discs in *O. mascula* and other species of Orchis, &c.

D. The disc after the first act of contraction, with no object seized.

E. The disc seen from above, and flattened by force, with one pollinium removed,—showing the depression by which the second act of contraction is effected.

F. The pollinia removed by the insertion of a needle into the nectary, after it has clasped the needle by the first act of contraction: side view.

G. The same pollinia after the second act of contraction and depression.

Platanthera ciliaris and *P. blephariglottis*, the Yellow and the White Fringed Orchis, flowering after midsummer, are as similar in their arrangements for fertilization as in general appearance. Under the present point of view, they are chiefly remarkable for having their viscid discs projecting much more even than in *P. orbiculata*, the anterior part of the anther-cell and the supporting arm of the stigma united (but readily separable, more plainly than in other species showing what belongs to each) tapering and lengthened to such a degree that the viscid discs are as if raised on a pedicel or tentacle, projecting considerably beyond the rest of the column. The anther-cells are nearly horizontal, and greatly divergent, but inclined somewhat inwards at the end; so that the discs are presented forwards and slightly inwards,—at least in *P. blephariglottis*, or in *P. ciliaris* more directly forwards. Evidently these projecting discs are to be stuck to the face or head of some nectar-sucking insect, of appropriate size, that visits the flowers. The stigma, which is rather small, is between the lateral arms, in the same horizontal line with the discs: the discs are small, but quite sticky, and directly affixed to the extremity of a caudicle or stalk which, in just proportion to the forward elongation of the anther-cell, &c., is remarkably long and slender, twice or thrice the length of the pollen-mass it bears. Upon removal by the head of an insect or any convenient foreign body, a slight bending or turning of the slender caudicle brings the pollen-mass into position for reaching the stigma. The discs, in ordinary flowers of *P. ciliaris*, are about a line and a half apart; the slender spur an inch long;—from which somewhat of the nature and size of the insect adapted to the work in hand may be estimated.

Platanthera fimbriata, the earlier Purple Fringed Orchis. In this the two lateral divisions of the labellum aid in hindering a lateral approach, while its middle division offers a convenient landing-place in front. The contracted base of the labellum is grooved, or with incurved margins, the trough leading as a sure guide to the narrow orifice of the nectary. The two anther-cells are widely separated, but little divergent; their anterior ends projecting strongly forward, the naked discs are brought just into line with the orifice or the nectary. The pointed tip of a pencil brought to the orifice of the latter, neatly catches the sticky discs and brings away the pollinia; when the movement, which is effected within a quarter or a third of a minute, converges them just enough to make them hit the broad stigma (which lies rather high) upon the re-application of the pencil. The 'drum-like pedicel' is present in this species also, but reduced to a minimum: the movement which takes place appears to result wholly from its change of form, the portion towards the anther contracting most, and to be one of depression solely.

Platanthera psycodes, the later and small-flowered Purple Fringed Orchis, is so nearly related to the last as by many to be regarded as a variety of it. It is more decidedly sweet-scented; and the claw-like base of the labellum is only slightly grooved. A development of the sides of the column as a kind of guard protects the discs laterally in this as in several other species, especially the last and *P. lacera*, preventing all ready access to the nectary except from the front. A stout bristle, slid along the base of the labellum and into the nectary for some distance

will not touch the viscid discs, they lying a little too far back: but on pushing it down deep into the long and curving spur (only the lower half or quarter of which is filled with nectar) it has to be bowed back somewhat, when it catches the discs. So that before an insect can have drained the nectary, the pollinia will be affixed to the base or upper part of its proboscis, or to the forehead of an insect of smaller size. When extricated, the movement of depression is prompt—within a few seconds,—and on re-application the pollen is accurately brought in contact with the stigma. The discs in place look forwards and downwards. We find in this species and in *P. lacera* (both common species and flowering at the same time in the latter part of summer), that the nectar appears to be much more plentiful in the spurs of older than of freshly-opened blossoms, most so indeed in flowers which had their pollina removed and their stigma fertilized several days before, and which were becoming effete. In such flowers the spur was often half full in the present species, and sometimes almost full in *P. lacera*. But although little had dripped down to the bottom of the spur in freshly-opened blossoms, the walls were moistened with nectar throughout its length.

Platanthera lacera, the Ragged Orchis, like the last, must be very attractive to some insects, the pollen-masses are so generally removed from oldish flowers, and the stigma fertilized. The nectary can be approached only from the front, the sides being thoroughly guarded by a broad and thick shield on each side—the arms of the stigma much developed—above supporting the anther, while its inner and concave face bears the remarkably long and narrow viscid discs: posteriorly, on its upper margin, a sort of cellular crest is developed. These guards come forward in front to within half a line of each other at the level of the discs; while above and below the space is wider. The viscid disc which adheres to the inner face of each guard or arm of the stigma, instead of orbicular and small, is lanceolate in shape, with the anterior end broadest, the posterior end acute: it lies transversely, with a slight obliquity: it is as long as the stalk of the pollen-mass, which is directly attached to it near the middle, no 'drum-like pedicel' intervening. When detached by a probe or bristle brought in contact with the viscid disc, a movement of depression takes place, by which the stalk and pollinium are brought down so as to be nearly parallel to the disc, and close to it,—just in proper position to reach the stigma upon bringing the probe back again to the orifice of the nectary.

Platanthera dilatata. The general structure of the flower in this species we had occasion to describe in the preceding number of the Journal (p. 259): this need not be repeated. It accords wih *P. lacera* in having very large and strap-shaped viscid discs, but in no other respect. For in this the anther-cells are appoximate and nearly parallel; and the discs are parallel and vertical, approximate, and placed just over the back side of the narrow orifice of the spur, looking forwards; they are nearly as long as the pollen-mass and its stalk together; the latter is short and flat, and is attached to its disc just below the summit of the latter. No movement of depression or of rotation was detected. The throat of the flower is a narrow chamber, bounded by the connivent-erect bases of the parts of the perianth; and the stigma and the discs lie so low in this

chamber that fertilization cannot be effected without insect-aid, and this can be given only by means of a proboscis. We find accordingly that a pig's bristle cannot be thrust down to the bottom of the spur and withdrawn without bringing away one of the pollinia. But the anther-cells are very early dehiscent, and the pollinia are often dislodged as soon as the flower opens. Yet from the arrangement of the parts, we think they can never fall over upon their own stigma, as they habitually do in the allied—

—*Platanthera hyperborea.* We have elsewhere stated (this volume, page 260) this species readily, and so far as we could ascertain from a few specimens, regularly *self-fertilizes* and without extraneous aid. We have nothing important to add to the brief account of the structure and process already described,—except that the packets of pollen are looser and the threads that attach them to the caudicle weaker than usual; while the discs (which are oval and rather small) retain for a good while their viscidity. So that a fitting insect, on visiting the open flowers, in which the pollen-masses have already fallen over on to the broad stigma underneath, will yet catch one or both the discs upon his proboscis, carry off the pollinia (which may be readily detached from the stigma, leaving some packets of pollen behind), and apply them in succession to the stigmas of other flowers of other individuals, and thus effect occasionally the crossing which is so uniformly effected in most species of the tribe. If the rule holds here as elsewhere, that a stigma is more sensitive to the pollen of another flower than to that of its own, there will be no lack of sufficient crossing in this species, wherever proper insects abound; where they do not, it will be prolific without them. We have observed that this species is very fertile, usually maturing all its ovaries. *Natura non agit saltatim*, and is more flexible and diversified in her ways than we are apt to think: many other cases of occasional or habitual self-fertilization may be expected among Orchids.

Gymnadenia tridentata is an additional instance of the kind, as we have elsewhere intimated (p. 260, foot-note), and one apparently so remarkable that we hesitate to bring forward our too scanty observations until another summer affords an opportunity to test them. We may venture to say, however, that, although the anther-cells open before the flower expands, and the pollen-masses are often spontaneuosly dislodged, —the discs being still in place,—yet, so far as we can see, they cannot of themselves fall upon or reach the stigma beneath. To do this they must be conveyed, in the usual way, upon an insect's proboscis, and most probably they often are so conveyed from one flower to another. Also, the pollen-packets are still more loose and separable than in *Platanthera hyperborea;* many of them are found spontaneously detached in the full-grown flower-bud or freshly expanded blossom, lying upon the open anther and adjacent parts, and especially upon the naked-cellular tip of the narrow process of the rostellum which rises between the two discs, and upon the cellular summit of the process outside of each disc. These are soft, moist, and somewhat viscid. The pollen which falls upon them adheres there, *and sends down pollen-tubes freely into their substance.* So that they appear to act as stigmas; although the normal stigma is found in its proper place and of ordinary appearance underneath the discs.

Having room for only two or three more brief notes, one of them shall be upon—

—*Goodyera.* We can only refer our readers to Darwin's description of *G. repens*, which is common in all our northern forests. We confirmed before we read Mr. Darwin's conjecture (on p. 114) "that the labellum moves farther from the column in mature flowers, in order to allow insects, with the pollina adhering to their heads or probosces, to enter the flowers more freely." Except that, if we mistake not, it is the column which changes its position, rather than the labellum. All freshly-opened blossoms have the column so directed—a little bowed forwards—that the tip of the *disc and of the anther* are presented to view as you look into the narrow opening of the flower; and a proboscis or bristle, introduced, and following as it will the curvature of the lip-like or nozzle-shaped apex of the labellum, and passed down to its saccate nectar-bearing base, will inevitably hit the disc, and if detained a moment, will bring the pollinia away when withdrawn. On re-introduction, the pollina will not pass down to the stigma, but lodge on the upper side of the column, from whence they were taken. But on looking into older flowers of the same spike, still fresh and good, and whether their pollina have been extracted or not, the *stigma* is in full view, the summit of the column (we believe) being now turned somewhat upwards or backwards; and there is now room enough between it and the labellum for the pollinia to pass; indeed now the pollinia will regularly hit the stigma, to which packets of pollen will plentifully adhere. So, as bees, &c. are said to begin at the bottom of a spike and to proceed regularly upwards, the pollen taken by them from the flowers of any spike will never fertilize other flowers of that spike, but will be carried to another plant, where it will fertilize the lower blossoms ready for it,—from which spike in turn pollen will be carried off to fertilize the flowers of a third plant, and so on!

Goodyera pubescens, although specifically quite distinct, accords with *G. repens* in all the above particulars.

Spiranthes, both *cernua* and *gracilis*, confirm Darwin's account: the difference in the position of the parts—the disc and anther presented in the younger, the stigma in the older flowers, just as in *Goodyera*—is so very striking that we wonder how we overlooked it last year. Here, also, we suspect that it is the column, rather than the labellum, which changes its position, but we have not been able to demonstrate it.

We are obliged to defer all account of observations upon native Orchids of other tribes, except *Cypripedium*, upon which we must hazard a few remarks. Mr. Darwin has been able to examine only a few tropical species, and those incompletely. The North American species and the allied one of Northern Europe would probably have modified his conclusions. In none of our species is the pollen "so glutinous that it can be drawn out into threads."

In *C. acaule* it is granular, pulverulent, and almost dry, except the surface (laid bare by the sphacelation or deliquescence of the whole anterior face of the anther), which is as if freshly coated with sticky varnish, and so adhesive that a body of small surface brought in contact with it

will bring away a piece of pollen of corresponding size; one of larger surface, like the tip of the finger or the head of a fly, brings away the whole mass of pollen of one or both cells. In the wild plants we find that the pollen is often carried off, either bodily or piece-meal. The stigma is rather concave than convex, and is slightly viscid.

In *C. pubescens*, *parviflorum* and *spectabile*, the whole pollen (equally exposed by the destruction of the face of the anther after dehiscence) is pulpy but very little glutinous.

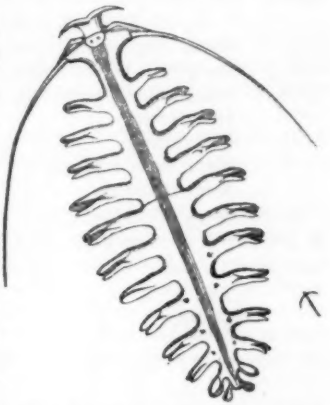
In all the species it is impossible that fertilization should be effected without extraneous aid. That aid may perhaps be given in the manner that Mr. Darwin supposes (but hardly in *C. spectabile*), that is, by a large insect inserting its proboscis into either of the lateral entrances at the base of the labellum, under the anther, and so thrusting some of the pollen forwards to the stigma, or more likely carrying some away to another flower, and leaving it on its stigma while attempting to gather the slight glutinous exudation that moistens the beard of long hairs which line the labellum underneath. But an attentive consideration of the arrangement in the species above mentioned, convinces us that the work is done by insects, such as flies, which crawl bodily into the flower. They may enter by one lateral opening, and so take a load of pollen upon the back of the head as they pass under the anther, which they would rub against the stigma, since they must crawl directly under it to feed on the nectar of the beard close underneath; and, escaping by the opening under the other anther, they would carry off some of its pollen to the flower of the next plant visited. But, although we have not been able to detect insects actually at work, we confidently gather from their traces, and from a variety of facts which we cannot here enumerate, that they ordinarily go in by the front entrance (even in *C. acaule*), crawl under the ample face of the stigma as they feed, where they cannot well avoid rubbing their heads or backs against the stigma, and passing on, make their exit by one of the lateral openings which now become visible to them, almost inevitably carrying off pollen on their head or shoulders as they escape, which pollen they would convey to the stigma of the next flower. Now the stigma offers no slight confirmation of this hypothesis, in a structure which has never before been noticed, but which is very striking in *C. spectabile*, &c., and most admirably adapted to the end in view. That is, the broad stigma, instead of being smeared with glutinous matter, as in ordinary Orchids, is closely beset with minute, rigid, sharp-pointed papillæ, all directed forwards,—so that the surface, when magnified, is like that of a wool-card of the olden time; and any pollen which an insect, working its way upwards to the base of the labellum, carries upon its head or back (to which alone it could be expected to adhere) would be neatly *carded* off by and left upon the stigma. The beauty of these adaptations can be appreciated only by actual inspection of the parts or of a series of figures.

We cannot close without an expression of gratitude to Mr. Darwin for having brought back teleological considerations into botany. So difficult is the study of functions in plants, so impossible often to find out the use or meaning of the various modifications of organs, and so unscientific and foolish the conjectures which are apt to be hazarded upon the

subject, that Geoffroy's saying, 'science knows nothing of intention in nature' had well nigh become a conceded, even if unexpressed principle in natural history, especially in botany. Under the study of homologies —so fertile in excellent results—botany and even zoology have become almost exclusively morphological. In this fascinating book on the fertilization of Orchids, and in his paper explaining the meaning of dimorphism in hermaphrodite flowers, Mr. Darwin,—who does not pretend to be a botanist—has given new eyes to botanists, and inaugurated a new era in the science. Hereafter teleology must go hand in hand with morphology, functions must be studied as well as forms, and useful ends presumed, whether ascertained or not, in every permanent modification of every organ. In all this we *faithfully* believe that both natural science and natural theology will richly gain, and equally gain, whether we view each varied form as original, or whether we come to conclude, with Mr. Darwin, that they are derived;—the grand and most important inference of *design in nature* being drawn from the same data, subject to similar difficulties, and enforced by nearly the same considerations, in the one case as in the other. A. G.

Zoology—

3. *Upon a new species of Tomopteris.*—This minute worm, of which a magnified figure (made by Prof. Dana while in the East Indies) is here given, agrees in generic characters, (as they are stated by Grube, in *Die Familien der Anneliden,*) with *T. onisciformis*, from the figure of which however, (published by Quoy and Gaimard, in the *Ann. des Sci.*, 1re Sér., T. x,) it differs very markedly. It will be seen that, in the want of a tail, it corresponds to what Carpenter and Claparède—as reported by Dr. Leuckart, *Wiegm. Arch.*, 1860-61—have regarded as the young condition of *T. onisciformis;* but the minute size of the specimen, in connection with the absence of the anterior pair of bristles, which are also reported to characterize the young, make it highly improbable that we have here an immature form. Prof. Dana having very kindly placed at the disposal of the writer his occasional observations upon the Annelids made during the Wilkes Exploring expedition, among which the above figure occurs, the name of *Tomopteris Danæ* is proposed for this new species. It was found by him in the Sooloo sea in Jan., 1842. In his notes it is remarked that "the fingers of each arm do not fold against one another; they constitute a forked extremity to the arm, the forks lying nearly in the same vertical plane and diverging about 60°." W. C. M.



November 3, 1862.

III. ASTRONOMY AND METEOROLOGY.

1. *Name of Asteroid* (56).—In vol. xxxii, p. 438, was given an account of the re-discovery of asteroid (56) to which the name of Pseudo-Daphne had been provisionally given. M. Schubert has since selected for this planet the name of Melete, daughter of Uranus. The following corrected elements of Melete have been furnished by R. Luther.

Epoch 1861, Oct. 24, 0^h, m. t. Berlin.

Mean longitude at epoch,	323° 22′ 52″·49
Longitude of perihelion,	293 39 30 ·00
Longitude of ascending node,	194 24 17 ·03
Inclination of orbit,	8 1 49 ·05
Excentricity,	0·2368702
Mean daily motion,	847″·49126
Mean distance,	0·2597651

When in opposition and at its mean distance, this planet is equal to a star of the 12th magnitude.

2. *The Asteroids Feronia and Niobe.*—The asteroid Feronia, at first numbered (72), having been discovered before Niobe, the numbers have been changed accordingly, and Feronia is now designated by the number (71), while Niobe is designated by the number (72).

3. *Name of Asteroid* (73).—In vol. xxxiii, p. 436, was announced the discovery of asteroid (73). To this planet has been given the name of Clytia. The following elements were computed by T. H. Safford.

Epoch 1862, May 2d, 0^h, m. t. Washington.

Mean longitude at epoch,	184° 30′ 53″·6
Longitude of perihelion,	61 11 13 ·5
Longitude of ascending node,	7 32 23 ·7
Inclination,	2 24 49 ·6
Excentricity,	0·0439797
Mean daily motion,	815″·029
Mean distance,	·2666177

4. *Discovery of Asteroid* (74).—This planet was discovered by Henry M. Parkhurst of New York, Sept. 25, 1862. The following observations have been furnished by Mr. Parkhurst.

Washington m. t.		App. R. A.	App. Dec.
Sept. 25,	$7^h\ 46^m$	$23^h\ 46^m\ 36^s$	+1° 5′
26,	7 42	45 59	0 58
27,	8 17	45 17	0 51
29,	8 9	43 56	0 36

The brightness of this planet is equal to that of a star of the eleventh magnitude.

5. *Discovery of Comet* I, 1862.—On the 2d of July, M. Tempel at Marseilles discovered near β Cassiopeiæ, a comet which had the brightness of a star of the 4th or 5th magnitude. On the same evening the comet was discovered at Athens by M. Schmidt. Its apparent diameter was from 20′ to 25′. On the 3d of July, the same comet was discovered also by Prof. Bond at the Cambridge Observatory. Between the 3d and 4th its daily motion, reduced to the arc of a great circle, was 24°, indicating a close proximity to the earth. Its distance from the earth on the

4th of July was by computation only nine millions of miles. The following elements have been computed from observations of July 3, 13, and 23d.

$$\begin{aligned} T &= 1862, \text{ June } 22{\cdot}06776 \text{ Berlin.} \\ \pi &= 299^\circ\ 20'\ 27''{\cdot}0 \\ \Omega &= 326\ 32\ 53\ {\cdot}5 \\ i &= 7\ 54\ 26\ {\cdot}1 \\ \log. q &= 9{\cdot}991818 \end{aligned}$$

Motion retrograde.

6. *Comet II*, 1862.—The discovery of this comet, July 18th, at the Dudley Observatory, was mentioned in the last number of this Journal, p. 294. On the same evening this comet was discovered at the Cambridge Observatory by H. P. Tuttle. On the 22d of July it was discovered at Florence; on the 25th it was discovered at Rome; and on the 26th it was discovered independently at Copenhagen.

The following elements have been computed from observations of July 24, 31, and Aug. 6th.

$$\begin{aligned} T &= 1862, \text{ Aug. } 23{\cdot}08967. \quad \text{m. t. Milan.} \\ \pi &= 344^\circ\ 33'\ 28''{\cdot}7 \\ \Omega &= 137\ 12\ 15\ {\cdot}2 \\ i &= 66\ 12\ 50\ {\cdot}4 \\ \log. q &= 9{\cdot}983886 \end{aligned}$$

Motion retrograde.

On the 15th of August this comet attained a north declination of 82°, and for five weeks from its first discovery, it remained within the circle of perpetual apparition. It was nearest to the earth on the 31st of August, when its distance was thirty-three millions of miles; and it would have appeared to great advantage had it not been for the light of the moon, then at the first quarter.

7. *Minima of Algol.*—The following are the computed dates of minimum brightness of Algol for November and December, 1862, expressed in Greenwich mean time.

Nov.	2.	18h 36m	Nov.	25.	17h 7m	Dec.	18.	15h 38m*
	5.	15 25*		28.	13 56*		21.	12 27*
	8.	12 14*	Dec.	1.	10 45		24.	9 16
	11.	9 3		4.	7 34		27.	6 4
	14.	5 51		7.	4 22			

The dates marked with an asterisk will be convenient for observation in this country, and it is hoped they will not entirely escape the attention of observers.

8. *Maximum of Omicron Ceti.*—The brightness of Omicron Ceti was carefully observed during the past summer by M. Schmidt, at Athens, and the time of its maximum fixed at July 2d. It was then slightly fainter than Alpha Ceti. As the period of this star is 332 days, the next maximum will occur May 30, 1863, which probably however cannot be observed on account of proximity to the sun.

METEOROLOGY.

9. *Detonating Meteoric fireball of Dec. 3d*, 1861.—Prof. E. Heis publishes in his "*Wochenschrift für Astronomie, &c.*" a detailed account of a bright meteoric ball which exploded with a loud detonation a few miles N.E. of Halle, about 7 o'clock, P. M., Dec. 3d, 1861. It was seen through-

out Germany, even as far as Vienna, 300 miles distant. He received about forty accounts of its appearance, some of them from persons accustomed to observations upon fireballs and shooting stars. The places of the observers were such as to give excellent data for computing the meteor's path. Few of these bodies have been better observed.

Prof. Heis concludes that it first appeared at an altitude of 130 English statute miles over N. lat. 52° 30′, E. long. 11° 55′, that is, a few miles N.E. of Magdeburg. It exploded, breaking into two or three parts, at an altitude of 57 miles, over N. lat. 51° 38′, E. long. 12° 10′. The length of path was 88 miles, and the course sharply downwards, making an angle of about 50° with the horizon. It moved about 10° east of south.

The interval of flight was variously estimated, but most of the observers called it from three to five seconds. Four seconds gives a relative velocity of 22 miles. The diameter of the meteor he estimated at more than 900 feet.

Its brilliancy, at the distance of 140 miles, equalled that of the full moon. At Vienna it was at first equal to Venus, but increased to three times the brilliancy of that planet. At Berlin, 100 miles distant, the light was considered equal to that of a gaslight. Prof. Heis hence estimates its intrinsic light as 68,000,000 times that of an ordinary gas flame.

The first altitude of this body is probably greater than that of any *large* fireball whose path has been determined with tolerable accuracy.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Thirty-second Meeting of the British Association for the Advancement of Science.*—The British Association met this year at Cambridge, on the 1st of October and adjourned after a week's session. This thirty-second meeting appears to have been less interesting and by far less numerously attended than most of the former sessions of this body. The address of the President, Prof. Willis, is given in full by the London Athenæum of Oct. 4, but is too long to transfer to our pages, especially as its contents are not particularly interesting to American readers. We copy the following abstract of Prof. Willis's address from the Chemical News of Oct. 11:—

This address was devoted to a statement of the objects of the Association, a history of its proceedings, and a detailed account of the various grants of money made by it, for the advancement of science, during the thirty years of its existence. The last, it seems, have amounted to 20,000*l.* Two thirds, or twelve parts of this sum, it appeared, had been expended on the sections of mathematics and physics; geology and mechanical science had received two parts each; and one part had been given to botany and zoology. It further appeared that very little had been devoted to the advancement of chemistry, only one-eighteenth having been divided among the sections of chemistry, geography, and statistics; and we believe it may be added with truth, that but a very small proportion of this eighteenth has been allotted to the first of these sciences. The large share assigned to the first section, the President said, was sufficiently accounted for by the nature of the subjects included in it, which require innumerable and expensive instruments of research, observations, and expeditions to all parts of the globe. The principal items of expenditure mentioned were for catalogues of the stars, the maintenance of Kew Observatory, observations to determine the course of the tide wave in various parts of the

world, and for the construction of instruments, and a series of observations and surveys in connection with meteorology and terrestrial magnetism. 2600*l.* have been expended on geology; 1600*l.* of which were employed in the completion of the fossil ichthyology of Agassiz, and Owen's reports on fossil mammalia and reptiles; and 900*l.* had been paid for experiments conducted by Mr. Scott Russell on the forms of vessels. The results of these valuable experiments were ready for press in 1844, but the great expense of printing them has hitherto prevented their publication, which is no doubt to be regretted. 900*l.* have been expended on zoological researches in different districts and countries; much of it on dredging committees for obtaining specimens of the marine zoology of our own coasts. 200*l.* have been disbursed by a committee formed in 1840 to make experiments on the preservation of the vegetative power in seeds, which have resulted in the discovery, that the greatest age at which seeds were found to vegetate was about forty years.

As is usual on these occasions, the President, in his address, passed in review the principal scientific events of the year, chemistry being referred to as follows:—"In chemistry the greatest advance which has been made during the past year is probably the formation of compounds of carbon and hydrogen by the direct union of those elements. M. Berthelot has succeeded in producing some of the simpler compounds of carbon and hydrogen by the action of carbon intensely heated by electricity or hydrogen gas; and from the simpler compounds thus formed he is able to produce, by a succession of steps, compounds more and more complex, until he bids fair to produce from inorganic sources all the compounds of carbon and hydrogen which have hitherto been only known as products of organic origin. Mr. Maxwell Simpson has also added to his former researches a step in the same direction, producing some organic products by a synthetical process. But these important researches will be fully laid before you in the lecture on Organic Chemistry which Dr. Odling has kindly promised for Monday evening next. Dr. Hofmann has continued his indefatigable researches on Poly-ammonias, as well as on the coloring matters produced from coal tar. Mr. Schlœsing proposes a mode of preparing chlorine by a continuous process, which may, perhaps, become important in a manufacturing point of view. In this process nitric acid is made to play the same kind of part that it does in the manufacture of sulphuric acid, the oxyds of nitrogen acting together with oxyds of manganese as carriers of oxygen from the atmosphere to the hydrochloric acid. The methods of dialysis announced last year by the Master of the Mint, (Prof. Graham) and of spectrum analysis, are now in everybody's hands, and have already produced many interesting results."

After a short notice of some public works, the learned President alluded to the lamented death of Prince Albert, and the loss of Professors Cummings and Henslow, who filled the chairs of Chemistry and Botany at Cambridge, and so concluded an address which was generally thought to be decidedly dry and somewhat dull.

In proposing a vote of thanks the Dean of Ely amused the audience by wishing Professor Willis life, happiness, and prosperity till he had completed his report on "Acoustics" (a work begun in 1832); and the learned Dean thought that all would agree with him, that he who desired the longest life could not desire a longer than he wished the Professor.

The various Sections commenced their sittings on Thursday morning. As has been the case at the two last meetings, the greatest interest seemed to be excited by the discussions in Section D, which bore on the Darwinian theory, most of the visitors, scientific and non-scientific, lay and clerical, male and female, appearing particularly anxious to learn the exact relationship (if any) which existed between a man and a monkey.—Section B, Chemical Science, had the usual select audience. It was presided over by Professor W. H. Miller, and the Secretaries were Dr. Odling, Professor Roscoe, and W. H. Elphinstone, M.A.

We add a few notices of some of the papers read before the various sections:—

A. Physical Section.—President, G. G. Stokes.—*On the extent of the Earth's Atmosphere*; by Prof. Challis.—The object of this paper was to show that the earth's atmosphere is of limited extent, and reasons were adduced, in the absence of data for calculating the exact height, for concluding that it does not extend to the moon. It was argued on the hypothesis of the atomic constitution of bodies, that the upward resultant of the molecular forces on any atom, since it decreases as the height increases, must eventually become just equal to the force of gravity, and that beyond the height at which this equality is satisfied, there can be no more atoms, the atmosphere terminating with a small finite density. It has been generally stated that the earth's atmosphere is about 45 miles high, but on no definite grounds, and the estimates of the height have been very various. Against the opinion that it extends as far as the moon, it was argued, that, as the moon would in that case attach to itself a considerable portion by its gravitation, which would necessarily have some connection with the rest, there would be a continual *drag* on the portion more immediately surrounding the earth, and intermediately on the earth itself, which would in some degree retard the rotation on its axis. Hence, if, as there is reason to suppose, the rotation be strictly uniform, the earth's atmosphere cannot extend to the moon. The author also stated that if by balloon ascents the barometer and thermometer were observed at two heights ascertained by observation, one considerably above the other, and both above the region in which the currents from the equator influence the temperature, data would be furnished by which an approximate determination of the height of the atmosphere might be attempted.

On the Augmentation of the Apparent Diameter of a body by its Atmospheric Refraction; by the Rev. Prof. Challis.—For reasons given in the preceding communication, it was assumed that atmospheres generally have definite boundaries at which their densities have small but finite values. Two cases of refraction were considered: in the one, the curvature of the course of a ray through the atmosphere was assumed to be always less than that of the globe it surrounds; and in the other, the curvature of the globe might be the greater. The former is known to be the case of the earth's atmosphere; and it was supposed that, *à fortiori*, this must be the case with respect to any atmosphere the moon may be supposed to have. On this supposition it was shown that the apparent diameter of the moon, as ascertained by measurement, would be greater than that inferred from the observation of an occultation of a star, because, by reason of the refraction of the atmosphere, the star would disappear and reappear when the line of vision was within the moon's apparent boundary. The same result would be obtained from a solar eclipse. It was stated that, by actual comparisons of the two kinds of determinations, such an excess to the amount of from 6″ to 8″ was found. This difference may reasonably be attributed to the existence of a lunar atmosphere of very small magnitude and density. The author also stated that from this result there would be reason to expect, in a solar eclipse, that a slender band of the sun's disk immediately contiguous to the moon's border would be somewhat brighter than the other parts, and advised

that especial attention should be directed to this point on the next occurrence of a solar eclipse. The case in which the curvature of the path of the ray is greater than that of the globe was assumed to be that of the sun's atmosphere; and it was shown, on this supposition, that all objects seen by rays which come from the sun's periphery are brought by the refraction to the level of the boundary of the atmosphere, whether they proceeded from objects on the surface of the interior globe, or from clouds supposed to be suspended in the atmosphere. Accordingly, the contour of the sun should appear quite continuous, and the augmentation of apparent semi-diameter will be equal to the angle subtended at the earth by the whole height of the atmosphere. The apparent diameters of the planets will, for like reasons, be augmented to a certain amount by the effect of refraction; and on account of the great distances of these bodies from the earth, the eclipse of a satellite will take place, as soon as the visual ray is bent by the interposition of the atmosphere.

Provisional Report on Thermo-electric Currents in Circuits of one Metal; by Mr. F. JENKIN.—Mr. Jenkin first gave a short description of the electrical currents to which he had drawn the attention of the Association at their previous meeting, as due to loose contacts between two unequally heated wires of one metal. Experiments were then described with loose contacts between wires of two dissimilar metals. The great intensity of the currents so obtained, compared with the ordinary thermo-electric currents from metallic contact between the two metals was pointed out; and it was shown that an analysis of the results proved, beyond doubt, that the currents were of the same nature as those produced by unequally-heated metals placed in an electrolyte: the thin films of melted oxyds of copper and iron constitute this electrolyte with unequally-heated junctions at surface of the two wires. This theory requires that the oxyd of copper should be considered far more positive than iron, and the oxyd of iron far more negative than copper. Direct experiments with oxyds of iron and copper between platinum wires confirmed this conclusion. It was, however, still considered doubtful how far electrolytes could be included in a true thermo-electric scale. It was stated that Sangoni had, in 1853, anticipated some of these results. A suggestion was then made that the current observed by Magnus and others at the first metallic contact of unequally-heated wires of one metal may be due to the fact that the electrical qualities of a perfectly homogeneous metal do not depend solely on its temper and temperature, as has been hitherto supposed, but to some extent on the time during which it has been maintained at that temperature; a fact proved, as regards electrical resistance by Mr. Mathiessen. In support of this view, it was stated that the currents obtained from these metallic contacts are not instantaneous, as generally supposed, but continue for, at least, five minutes after contact has been made, gradually diminishing from a maximum to a zero.

On the Zodiacal Light and Shooting Stars; by Prof. CHALLIS.—The phenomena of the zodiacal light, as gathered from observations made both in northern and in southern latitudes, were stated to be as follows:—As seen in north latitudes, it appears in the west after the departure of twilight, as a very faint light, stretching along the ecliptic, about 10°

broad at its base in the horizon, and coming to an apex at an altitude of 40° to 50°. It is most perceptible in the west in the months of February and March, at which time its apex is near the Pleiades. Similar appearances are presented in the morning before sunrise in the east, in the months of August and September. The light seen in the autumn lies in the *same* direction from the sun as that seen in the spring. In the southern hemisphere, the appearances are strictly analogous; but the times and positions of maximum visibility are the evenings in autumn in the west and the mornings in spring in the east. The portion best seen in the southern hemisphere lies in the *opposite* direction from the sun to that which is best seen in the northern hemisphere. The portion seen and the degree of visibility depend on the inclination to the horizon of the part of the ecliptic along which the light stretches. The greater the inclination, the better it is seen. At the December solstice, opposite portions have been seen in the northern hemisphere, one in the morning and the other in the evening; and in the southern hemisphere opposite portions have been similarly seen at the June solstice. At these seasons, the ecliptic is inclined at large and equal angles to the horizon, at equal intervals before sunrise and after sunset.

On Autographs of the Sun; by Prof. Selwyn.—Prof. Selwyn showed several "autographs of the sun," taken with his "heliautograph," by Mr. Titterton, photographer, Ely, which consists of a camera and instantaneous slide, by Dallmeyer, attached to a refractor of $2\frac{3}{4}$ inches aperture, by Dolland; the principle being the same as that of the instrument made, at the suggestion of Sir J. Herschell, for the Kew Observatory; and the Professor expressed his thanks to Mr. Balfour Stewart and Mr. Buckley for their advice. The autographs are of July 25, 26, 28, 29, 31; August 1, 2, and August 4, 10, 15 A.M. and 11.30 A.M. (a series of bright days coincident with a large group of spots); August 19, 20, 23, and 25, where the same group reappears much diminished; September 19, 23, 26 and 30, in which is seen a group of spots 118,000 miles in length. On the 23d three autographs are taken, two of them with the edge of the sun in the centre of the photographic plate, showing that the diminution of light towards the edges of the disc is a real phenomenon, and not wholly due to the camera. In the two of the 4th of August, where the great spot (20,000 miles in diameter) appears on the edge, a very distinct *notch* is seen, and the sun appears to give strong evidence that the spots are cavities; but eye observations and measurements by the Rev. F. Howlett, and others, tend to show that this evidence is not conclusive, for there was still a remaining portion of photosphere between the spot and the edge. The phenomena shown in these autographs appear to confirm the views of Sir J. Herschell, that the two parallel regions of the sun where the spots appear, are like the tropical regions of the earth, where tornadoes and cyclones occur, and those of Wilson in the last century. The *faculæ* seem to show that the tropical regions of the sun are highly agitated, and that immense waves of luminous matter are thrown up, between which appear the dark cavities of the spots, whose sloping sides are seen in the penumbræ, as explained by Wilson and others. Other analogies between solar spots and earthly storms were pointed out, and reference was made to the glimpses of the structure of the sun exhibited by Mr. Nasmyth as confirming the above views.

Some Peculiar Features in the Structure of the Sun's Surface; by JAMES NASMYTH.—The author said the subject was in itself most interesting, but had been rendered much more so by the researches of Bunsen and others upon the solar spectrum. He himself had paid much attention to the structure of the sun and moon, but lately more particularly to that of the sun. He had been fortunate enough to secure some exceedingly perfect instruments, and a very favorable condition of the atmosphere. His first observation of the phenomena he was about to describe was made on July 20, 1860. It is still a mooted point as to what the spots on the sun really are, but it is generally supposed that they are openings on the luminous surface. When observing these appearances he noticed that the outer luminiferous envelope of the sun was composed of lenticular or willow-shaped filaments, and it is from these that the whole of the solar light emanates. Next to this comes the penumbra, then a misty envelope, and lastly the body of the sun itself, which is dark, dense, and not a light-giving substance. The willow-shaped filaments mentioned are not distributed in symmetrical order, but in a heterogeneous mass. This accounts for the mottled appearance of the sun, seen by the most common observer through a telescope. He would offer no hypothesis as to what the composition or the functions of this luminiferous envelope might be, but thought it had better remain till a great number of facts had been collected. His sole object was to introduce to the notice of scientific men the facts he himself had collected.

Mr. Nasmyth, in answer to some questions put to him, stated that he had used Sir John Herschel's eye-glass, of which he detailed the construction. The size of the willow-shaped filaments he should imagine, at a rough guess, to be 1000 miles long by 90 broad. The most suitable magnifying power for observing this phenomena is 200; for, as the air is seldom tranquil with a higher magnifying power, it is difficult to retain distinctness. The luminous tracts composing the outer envelopes seem to be in motion among themselves, moving with enormous velocity; and when a spot upon the surface of the sun ceases to be so any longer, they come sailing across to fill up the space, like (said Mr. Nasmyth) a shoal of herrings.

B. CHEMICAL SECTION.—President, W. H. MILLER.—*On the Luminosity of Phosphorus;* by Dr. MOFFAT.—If a piece of phosphorus be put under a bell-glass and observed from time to time, it will be found at times luminous, and at others non-luminous. When it is luminous, a stream of vapor rises from it, which sometimes terminates in an inverted cone of rings similar to those given off by phosphoretted hydrogen; and at others it forms a beautiful curve, with a descending tint equal in length to the ascending one. The vapor is attracted by a magnet; it is also attracted by heat, but it is repelled by cold. It renders steel needles magnetic, and it is perceived only when the phosphorus is luminous. Results deduced from daily observations of the phosphorus in connection with the readings of the barometer, the temperature and degree of humidity of the air, with directions of the wind, for a period of eighteen months, show that periods of luminosity of phosphorus and non-luminosity occur under opposite conditions of the atmosphere; the former being peculiar to the equatorial, while the latter is peculiar to the polar current. By the catalytic action of phosphorus on atmospheric air, a gaseous body

(superoxyd of hydrogen) is formed, which is analogous to if not the same as atmospheric ozone, and it can be detected by the same tests. The author has found, by his usual tests, that *phosphoric* ozone is developed only when the phosphorus is luminous. Periods of luminosity and periods of atmospheric ozone take place under similar atmospheric conditions, and the conditions of non-luminous periods and periods of non-atmospheric ozone are the same. From the author's observations in connection with this matter, which extend over several years, it appears that 99 per cent of luminous periods and 91 per cent. of ozone periods commence with decreasing readings of the barometer and other conditions of the equatoreal current; and that 94 per cent and 66 per cent terminate with increasing readings and the conditions of the polar current. Luminous periods commence and luminosity increases in brilliancy on the approach of storms and gales, and ozone periods commence and luminosity increases in quantity under similar conditions. There is, it would appear also from these observations, an intimate connection between the approach of storms, the commencement of luminous and ozone periods and disorders of the nervous, muscular and vascular systems. Here the author gave the dates of many storms and gales, and the occurrence of diseases of the above class, showing their coincidence; and in corroboration of what he had stated, he mentioned the fact that there was a concurrence in the issuing of Admiral FitzRoy's cautionary telegrams and these diseases. He also stated that he views the part performed by ozone in the atmosphere as being similar to that performed by protein in the blood; the latter giving oxygen for the disorganization of worn-out tissues in the animal economy,—the former giving oxygen to the products of decomposition and putrefaction, and rendering them innocuous or salutary compounds. With these views he has used phosphorus as a disinfectant; and from the results he has obtained, he believes that by using ozone artificially formed by the action of phosphorus in localities tainted with the products of putrefaction, just in sufficient quantity to tinge the usual test-paper, all diseases of the pythogenic class would be prevented. Although the data are too few to theorize upon, Dr. Moffat hoped that he would be excused for pushing the matter beyond a simple statement of facts and observations, as many facts had been observed in nature which strongly corroborated all he had advanced. Ozone, he observed, is in all probability formed wherever there is phosphorescence; and this is by no means an uncommon phenomenon. It is seen in life and in death, in the animal and vegetable kingdoms, and in the mineral kingdom. Here many instances of phosphorescent bodies were enumerated, among which the night-shining Neries was named as becoming particularly brilliant with a direction of wind from points of the compass between east and south; and the fact that the sea becomes luminous on the approach of storms by marine animals floating on its surface was noticed. Many phosphorescent minerals were named; the fluor spar being particularly pointed out as being not only phosphorescent on slight increase of temperature, but as giving off ozone. The author concluded by observing that it is not improbable that atmospheric ozone is formed by the phosphorescence of these and similar bodies, and pointed to the absence of ozone and weak magnetic action during cholera periods, which are periods of non-lumin-

osity, and to the disappearance of cholera with the setting in of the equatorial current, which is ozoniferous and favorable to luminosity. The aurora, the author thinks, may yet be proved to be a display of luminosity.

C. Geology.—President, J. B. Jukes.—The President inquired how the variations of the surface called mountains, hills, cliffs, glens, valleys and plains were formed. He took, first, the formation of great plains, and showed that although some were formed as plains on horizontal beds, few even of these retained the original surface of deposition, but had more or less a denuded surface. Many equally level plains were low and level, because mountainous masses of rock, often greatly disturbed and contorted, had been removed from above the present surface. The central plain of Ireland, and other plains in the British Islands, were formed in this way. All mountains, except volcanoes or "hills of ejection," were either "hills of circumdenudation," formed by the wearing down and removal of the rocks formerly around them, or "hills of uptilting." In the latter, the lowest rocks appeared in the central parts of the chain, often reared into the highest peaks; and these central beds dip on either hand under higher and higher groups, which come in as we recede from the axis of the chain. The beds have been raised by mechanical force acting from below; but this, however it had tilted or bent them, could not remove them, so that the successive exposure of lower and lower beds as we approach the axis of the chain must be owing to the external erosion of moving water. These "hills of uptilting," then, were hills not in consequence, but in spite of denudation, and would have been many times loftier had it not been for the erosive action. Mr. Jukes declared his belief that all the striking external features were the result of the direct action of the external forces called the "weather," and were not caused by any direct action of the internal forces, which could only reach the surface through the thickness of the crust. He then examined these forces of erosion; and while he attributed to marine action all the greater and more general features, the great plains, the long escarpments, and the general outline of the mountains, he believed that the valleys which traversed the plains, the gullies that furrowed the sides of the hills, and the glens and ravines on the flanks of the mountains, were all due to the action of the ice or water which fell on them from the atmosphere. He did not give these views as altogether original, but mentioned Mr. Charpentier and Mr. Dana as having long ago applied them to the Pyrenees and to the Blue Mountains of New South Wales; but, having been long sceptical as to their reality, he now wished to record his conviction of their truth. Mr. Prestwich, Prof. Ramsay and himself, while pursuing different lines of investigation, had all been simultaneously compelled to appeal to the sub-aërial action as the only method of explaining the phenomena they had met with; and Dr. Tyndal had since fallen into the same line of march.

On the last eruption of Vesuvius; by Dr. Daubeny.—The author confines himself to those phenomena which appeared to present some novelty, and to have a bearing upon the general theory of volcanic action. Vesuvius appears during the last few years to have entered upon a new phase of action. Its eruptions are more frequent but less violent than they were formerly; they proceed from a lower level than they did at an earlier period; and they give vent to certain new volatile or gaseous

principles, such as the vapor of naphtha and and light carburetted hydrogen, or marsh gas, never before detected. The last eruption has likewise caused an elevation of the coast to the height of 3 feet 7 inches above the level of the sea, which has not been observed on any preceding occasion. In speculating upon the causes which have produced these changes in the nature of the operations of Vesuvius, the author first considers the theory which recognizes a second class of volcanoes distinct from those ordinarily known as such, and designated by the name of mud volcanoes. As these are characterized by the emissions of carburetted hydrogen and naphtha, as well as of semi-fluid mud, it might be suggested by those who regard them as partakers of the nature of volcanoes, that Vesuvius was now passing into the condition of a mud volcano from its emitting these same products. But the author finds reason for denying that the so-called mud volcanoes, of which Macalube in Sicily and Taman in the sea of Azof are types, have anything in common with genuine volcanoes, such as Vesuvius, and he therefore contends that the above products are generated simply owing to the action of volcanic heat upon contiguous beds of Apennine limestone containing bituminous matters imbedded. Hence would arise the enormous evolution of carbonic acid observed, and the carburetted hydrogens as well as naphtha vapor which are found to accompany it, and which may be regarded as the secondary and incidental products of volcanic action, whilst the muriatic and sulphurous acids are primary and effectual ones. The auther concluded by recommending to the explorers of volcanic phenomena the accurate examination of the gases evolved, as the best clue to the explanation of the true nature and cause of volcanic action. The latest remarks of Deville and others on volcanic emanations present nothing irreconcilable with the chemical theory of volcanoes which the author has so long espoused; but all he asks of geologists is, diligently to record the facts, chemical as well as physical, which volcanoes present, instead of contenting themselves with simply referring the eruptions to certain great cosmical changes which they imagine to be taking place.

D. Zoology.—President, Prof. Huxley.—*On the Zoological Significance of the Brain and Limb-characters of Man, with Remarks on the Cast of the Brain of the Gorilla;* by Prof. Owen.—Prof. Owen exhibited two casts, one of the human brain, which had been hardened in spirits, and had therefore not preserved its exact form, but to all intents and purposes it would serve as an illustration of the human brain. The other cast was taken from the interior of the cranium of the gorilla. From an examination of these, the difference between the brain of man and that of monkeys was at once perceptible. In the brain of man, the posterior lobes of the cerebrum overlapped, to a considerable extent, the small brain, or cerebellum; whereas, in the gorilla, the posterior lobes of the cerebrum did not project beyond the lobes of the cerebellum. The posterior lobes in the one were prominent and well marked; in the other, deficient. These peculiarities had been referred to by Todd and Bowman. From a very prolonged investigation into the characters of animals, he felt persuaded that the characters of the brain were the most steadfast; and he was thus induced, after many years of study, to propose his classsification of the mammalia, based upon the differences in the development of their brain structure. He had placed man—owing to the prominence of the

posterior lobes of his brain, the existence of a posterior cornu in the lateral ventricles, and the presence of a hippocampus minor in the posterior cornu,—in a distinct sub-kingdom, which he had called Archencephala, between which and the other members of the mammalia the distinctions were very marked, and the rise was a very abrupt one. The brain, in his estimation, was a far better guide in classifying animals than the foot; but the same difference that existed between their brains was also observable between their feet. The lecturer referred to a diagram which represented the feet of the aye-aye, the gorilla and man, pointing out the chief differences in the structure of the skeleton. These differences he considered sufficiently great to elevate man from the sub-kingdom to which the monkeys belonged, and to place him in a distinct sub-kingdom by himself.

Prof. Huxley observed that the paper just laid before the Section appeared to him in no way to represent the real nature of the problem under discussion. He would therefore put that problem in another way. The question was partly one of facts, and partly one of reasoning. The question of fact was, what are the structural differences between man and the highest apes?—the question of reasoning, what is the systematic value of those differences? Several years ago, Prof. Owen had made three distinct assertions respecting the differences which obtained between the brain of man and that of the highest apes. He asserted that three structures were "peculiar to and characteristic" of man's brain—these being the "posterior lobe," the "posterior cornu," and the "hippocampus minor." In a controversy which had lasted for some years, Prof. Owen had not qualified these assertions, but had repeatedly reiterated them. He (Prof. Huxley), on the other hand, had controverted these statements; and affirmed, on the contrary, that the three structures mentioned not only exist, but are often better developed than in man, in all the higher apes. He (Prof. Huxley) now appealed to the anatomists present in the Section whether the universal voice of Continental and British anatomists had not entirely borne out his statements and refuted those of Prof. Owen. Prof. Huxley discussed the relations of the foot of man with those of the apes, and showed that the same argument could be based upon them as on the brain: that argument being, that the structural differences between man and the highest ape are of the same order and only slightly different in degree from those which separate the apes one from another. In conclusion, he expressed his opinion of the futility of discussions like the present. In his opinion, the differences between man and the lower animals are not to be expressed by his toes or his brain, but are moral and intellectual. Prof. Rolleston said he would try and supply the members of the Association with the points of positive difference between the human and the ape brain. For doing this we had been abundantly shown that the hippocampus minor and the posterior lobe were insufficient. As differentive, they must be given up at last. But as much had recently been done for the descriptive anatomy of the brain by Gratiolet and others as had been done for astronomy by Stokes and Adams, for language by Max Müller, and that this had been ignored in this discussion was little creditable to British science. This analysis of the brain's structure had established as differentive between man and the ape four great differences—two morphological, two quantitative. The two quantitative are the

absolute weight and the great height of the human brain; the two morphological, the multifidity of the frontal lobes corresponding to the forehead, usually, popularly, and, as this analysis shows, correctly, taken as a fair exponent of man's intelligence, and the absence of the external perpendicular fissure. This had been abundantly shown by Gratiolet. No reference to these most important matters had been made by Prof. Owen; and this omission could not fail to put the British Association's repute for acquaintance with the works of foreign fellow-laborers at great disadvantage in the eyes of such foreigners as might be present.* Prof. Rolleston concluded by saying that if he had expressed himself with any unnecessary vehemence, he was sorry for it; but that he felt there were things less excusable than vehemence, and that the laws of ethics and love of truth were things higher and better than were the rules of etiquette or decorous reticence. Mr. W. H. Flower, looking at the subject solely in the anatomical view and as a question of fact, stated that the result of a considerable number of dissections of brains of various monkeys was that the distinction between the brain of man and monkeys did not lie in the posterior lobe or the hippocampus minor, which parts were proportionately more largely developed in many monkeys than in man, and that if these parts were used in the classification of man and the monkeys the series would be,—first, the little South American marmosets; then would follow the baboons, the cercopitheci, macaque; then man must be placed, followed by the anthropoid apes, the orang-outang, chimpanzee and gorilla; and last, the American howling monkey.—Prof. Owen replied, that Prof. Rolleston had led the meeting to conclude that he had not paid any attention to the convolutions of the brain of mammals, and that the investigation of this subject was the exclusive property of the German anatomists; whereas he might be permitted to state that almost at the very time that Leuret wrote his memoir on this subject, he had delivered a course of lectures on the convolutions of the brain, which, he regretted, had not been published, owing to the pressure of other labors; but the diagrams were still in existence, as his successor could testify, in the Museum of the Royal College of Surgeons.

2. *Correspondence of Sir Wm Reid and W. C. Redfield.*—John H. Redfield, of Philadelphia, son of the distinguished investigator of the law of Storms, has presented to the Library of Yale College, the original letters of Sir W. Reid to Mr. W. C. Redfield, and copies of the letters of the latter, to Sir William. The correspondence is arranged chronologically and is bound in three handsome folio volumes. In order that gentlemen devoted to meteorology may understand the character of this collection of letters, so important in the History of the science of Storms, we append a note of Mr. J. H. Redfield, introductory to the volumes.

"The correspondence contained in these volumes consists for the most part of the autograph letters of Sir William Reid to William C. Redfield of New York, together with copies of those written by the latter in reply.

Sir William Reid (then a Lieutenant Colonel in the Engineer Service of Great Britain) was appointed Governor of the Bermuda Islands at the close of

* For a statement of the present status of opinion on this subject, see p. 188. —*Eds.*

1838. In 1846 he was transferred to Barbadoes, having under his government all the British Windward Islands of the West Indies. In 1848 he resigned this post and returned to England, where he was soon after put in charge of the Engineer Department at Woolwich, and in 1850 was appointed Chairman of the Executive Committee for the Great Industrial Exhibition of 1851. After the close of the Exhibition the honor of knighthood was conferred upon him, and in the beginning of 1852 he was made Governor of Malta, where he remained till the close of 1857, when the health of Lady Reid had suffered so much from the debilitating climate that he was compelled to resign his post and return to England. These letters therefore cover the whole period of his active service as a civilian, and bear testimony to the active and untiring zeal which as a Colonial Governor he manifested for the permanent welfare of the people of his government. His efforts for the improvement of Agriculture and Education and for the promotion of Temperance were unremitting and were crowned with the most gratifying results and well earned for him the title of "*The Good Governor*"—applied to him in Dicken's Household Words.

To the man of science however, these letters also possess an interest of another kind. In 1831 Mr. Redfield had shown that the phenomena attending the gales of the Atlantic coast of the United States all unerringly testified that these storms were great whirlwinds moving from the tropical towards the polar regions in a determinate path. He followed up this induction by repeated investigations of subsequent storms which confirmed his earlier conclusions. He availed himself of these demonstrated laws of rotation and progression in the storm-winds, to point out to navigators the means of eluding the violence and shortening the duration of these gales. These earlier papers of Mr. Redfield fell under the notice of Col. Reid, while stationed at Barbadoes as an engineer officer, and were to him the first satisfactory solution of a problem which had long engaged his attention. From this time Col. Reid became an active laborer in the same field of investigation, and he opened the correspondence which follows—a correspondence which continued for nearly twenty years until terminated by the death of Mr. Redfield.

These letters are therefore in a peculiar manner illustrative of the history of the "development of the law of storms and variable winds," while they are equally illustrative of the mental activity as well as the simplicity and benevolence of character, which marked these two friends, and so long harmonious laborers in a common field—each longing for the personal acquaintance of the other, but destined to meet only in a brighter and nobler sphere.

A few letters from Lady Reid, with the replies thereto, are included in this collection. They are necessary to render the series complete, and are worthy of preservation not only from her terse, vivacious style, but because her communications sometimes shed a light upon Governor Reid's merits, which his own modesty would hardly reveal.

Mr. Redfield's letters have been copied from his own letter-book, and are therefore in most cases second copies, but they cannot differ materially from the originals. The copying of these letters, and the arrangement of this collection have been done by his eldest son, and the hours spent in this labor have been sweetened by the memories of a revered parent, to whose virtues those who best knew him can best testify.

New York, January, 1858."

3. *Supposed fall of meteoric iron at St. Louis, Mo.*—On the morning of July 9th, 1862, about 11 o'clock, "a strange sound was heard in the air over the houses on the south side of Chestnut, between Second and Third streets. At the same instant a noise resembling that of an explosion of a steam boiler startled the people in the vicinity, and this was immediately followed by a crash through one of the large windows of the office of

John Riggin, Real Estate Agent, on the North side of Chestnut street. A crowd of curious persons rushed to the spot, to find out something more of the unusual occurrence, when they were rewarded by the discovery that a piece of solid iron—or rather what appeared to be a mixture of iron and other substances—weighing about a quarter of a pound, had fallen from the upper regions. We learn that the piece of iron will be handed over to the Academy of Science."—*St. Louis newspaper.*

Dr. B. F. Shumard, to whom we are indebted for this information, adds: "The specimen has the appearance of meteoric iron, and when found, weighed 25·375 mm. gr., measured one inch and a half in length, about ten lines in width and a half an inch in thickness.

"It is stated to have come from a southwestwardly direction, passing over some houses on the south side of Chestnut street, betwen 2d and 3d streets, striking the window of the office of Mr. John Riggin, Real Estate broker on the north side of Chestnut street, shattering a large pane of glass a few inches above the ground floor and then bounding obliquely backwards several feet. Mr. Eugene Riggin was in the office at the time of the fall, three or four feet from the window, and immediately ran out and picked up the specimen. Mr. Riggin is regarded here by all who know him as a man of veracity. Several persons of respectability on the street also witnessed the fall, and all of them state that they distinctly heard a whizzing noise during the passage of the body through the air. These are the facts as I gathered them immediately after I heard of the fall. I confess that I was somewhat sceptical at first, but after ascertaining the above facts I became a believer. Dr. Litton subsequently made a qualitative analysis of a part of the specimen but could not find any nickel. So I am again in doubt."—*Letter from Dr. Shumard.*

VI. BOOK NOTICES.

1. *Dana's Manual of Geology.**—In our last number we announced the near completion of Prof. Dana's Geology. Before these lines are seen by our readers the book will be issued. Favored by an inspection of the advanced sheets we are able to give some notice of the scope and contents of the volume.

The first feature of the work which arrests attention is its thoroughly American character. We copy from the Preface what the author says on this point.

"Two reasons have led the author to give this Manual its American character: a desire to adapt it to the wants of American students, and a belief that, on account of a peculiar simplicity and unity, American Geological History affords the best basis for a text book of the science. North America stands alone in the ocean, a simple isolated specimen of a continent (even South America lying to the eastward of its meridians), and the laws of progress have been undisturbed by the conflicting movements of other lands. The author has, therefore, written out American Geology by itself, as a continuous history.

* Manual of Geology: treating of the principles of the science with special reference to American Geological History, for the use of Colleges, Academies, and Schools of Science. By James D. Dana, M.A., LL.D., Silliman Professor of Geology and Natural History in Yale College, &c., &c. Illustrated by a chart of the world and over one thousand figures, mostly from American sources. Philadelphia: published by Theodore Bliss & Co. London: Trübner & Co. 1863. Small 8vo, pp. 812.

Facts have, however, been added from other continents so far as was required to give completeness to the work and exhibit strongly the comprehensiveness of its principles."

It has long been a just source of complaint that the students of geology must seek in vain for any compact and well arranged view of the system of American Geology, and few but professional geologists have had the courage to wade through the voluminous mass of matter embraced in the official Reports of the various State Geologists; while still fewer have felt themselves able to reconcile the numerous discrepancies growing out of a want of unity in plan and nomenclature among the authors of these reports.

Prof. Dana, with that methodizing skill and philosophic power which is a prominent feature of his mind, has here for the first time produced in full detail what may be emphatically called the American System of Geology. The science is here taught from American examples, and while no important principle or class of phenomena is left unillustrated by the choicest European or cosmopolitan instances, the student is delighted by finding the keys of the subject in his own hands, the field of study and observation being within his own reach.

An immense impetus was given to the study of British Geology by the writings of Buckland, Sedgwick, Murchison, Lyell, Bakewell, Mantell, Hugh Miller, and others, not more from the vigor and beauty of their style as authors, than from the fact that the subject was brought home to British tourists by the local interest inseparable from the name and fame of familiar domestic scenes. Such a service has Prof. Dana rendered to American students and tourists in his present work. But we should do the author injustice if we left the impression that this was the most important feature of the work, interesting as this is to American students.

It is as the historian of the earth's progress through the successive stages of its development that the author has shown his original power. From this point of view the volume demands the attention of a wider audience than can be asked for any mere text-book or local manual. It marks an era in the history of geological literature, and as an Epic of the earth will be read with interest everywhere. Few geologists have seen more of the earth's surface than Prof. Dana, and his powers and opportunities as an original observer have been second only to his power of analysis of the true value of the labors of others. The same characteristics of accurate and exhaustive statement and lucid order, which have made Dana's Mineralogy an authority in all countries, will carry the Geology home to the tables of a yet larger constituency.

The spirit in which the book is written is well expressed in the concluding lines of the preface.

"Geology is rapidly taking its place as an introduction to the higher history of man. If the author has sought to exalt a favorite science, it has been with the desire that man—in whom geological history had its consummation, the prophesies of the successive ages their fulfillment—might better comprehend his own nobility and the true purpose of his existence."

The sources from which Prof. Dana has drawn his materials as well as the geologists to whom he is indebted for assistance, are thus acknowledged:

"In the preparation of the American part of the volume, the author has freely used the reports of the various geological surveys of the country, the memoirs published in the different scientific journals and transactions, and other works bearing on the subject. He has also drawn from his own Memoirs and Exploring Expedition Reports, especially on the subjects of Coral islands, —Volcanic islands,—the Formation of Valleys by the action of rivers,—the General Features of the Globe, and their origin,—American geological history,—and the Temperature of the Globe, as exhibited on the Physiographic Chart.

The illustrations of American Palæozoic life have been largely copied from the Reports of Professor Hall. A few of the Palæozoic figures, and many of later periods, are from original drawings made by Mr. F. B. Meek, to whose artistic skill and palæontological science the work is, throughout, greatly indebted. The drawings were nearly all made on the wood for engraving by Mr. Meek; and the palæontological pages have had the benefit of his revision. The name of the engraver, Lockwood Sanford, of New Haven, also deserves mention in this place.

In selecting figures of foreign fossils for the Manual, those used in Lyell's and other standard English works have, with few exceptions, been avoided, so that the student owning any of those volumes will have additional illustrations of the science. Many of the foreign figures are from the beautifully illustrated "Paléontologie et Géologie" of Alcide d'Orbigny.

The author would make acknowledgments to his countrymen for the readiness with which they have furnished aid, whenever appealed to, and especially, for oft-repeated favors, to J. P. Lesley, of Philadelphia; J. S. Newberry, of Cleveland, Ohio; Arnold Guyot, of Princeton, N. J.; L. Lesquereux, of Columbus, Ohio; E. Billings, of Montreal, Canada; E. Jewett, of Albany, N. Y.; and W. C. Minor and Frank H. Bradley, of New Haven. Mr. Bradley has given freely his constant assistance during the progress of the volume through the press."

The work is divided into four parts. Part I, Physiographic Geology. Part II, Lithological Geology. Part III, Historical Geology. Part IV, Dynamical Geology.

To assist those not familiar with Zoology, a review of the classification of animals, with many illustrations, is given before entering upon the History of the ancient life of the world.

By printing the details in a finer type the book has been adapted to two classes of students—the literary and scientific. The convenience of a literary class has been further provided for by the addition of a brief synopsis of the work in which each head is made to present a subject, or question for special attention. A catalogue of American localities of fossils is also in the Appendix and will greatly aid the researches of young collectors.

The printer, publisher, and engraver have each done their best to make this volume attractive and useful. The wood-cuts in particular are of unusual excellence, and show the value of condensation and good taste in arrangement in saving space, the wonder being that over one thousand figures can be so compendiously and clearly exhibited. S.

2. *Contributions to the Ethnography and Philology of the Indian Tribes of the Missouri Valley.* By Dr. F. V. Hayden. 230 pages, 4to, with a map and two plates. From the Transactions of the American Philosophical Society, 1862.—We have received a separate copy of this important memoir, which forms Part 2d of the XIIth vol. of the Transactions of the American Philosophical Society. Dr. Hayden has enjoyed

excellent opportunities for the study of the languages and habits of our North American Indians, while engaged in the geological exploration of the Upper Missouri. Our readers will recall his article on the Mandan Indians on page 57 of this volume. The contents of the present memoir, after an introduction, embrace the following subjects:

ALGONKIN GROUP, A.

II. Knisteneaux, or Crees—Ethnographical History; III. Blackfeet—Ethnographical History; IV. Remarks on the Grammatical Structure of the Blackfoot Language; V. Vocabulary of the Sik-si-ká, or Blackfoot Language; VI. Shyennes—Ethnographical History; VII. Remarks on the Grammatical Structure of the Shyenne Language; VIII. Vocabulary of the Shyenne Language.

ARAPOHO GROUP, B.

IX. Arapohos—Ethnographical History, and Remarks on the Grammatical Structure of their Language; X. Vocabulary of the Arapoho Language; XI. Atsinas—Ethnographical History and Vocabulary.

PAWNEE GROUP, C.

XII. Pawnees—Ethnographical History and Vocabulary; XIII. Arikaras—Ethnographical History and Vocabulary.

DAKOTA GROUP, D.

XIV. Dakotas—Ethnographical History and Vocabulary; XV. Assiniboins—Ethnographical History and Vocabulary; XVI. Aub-sá-ro-ke, or Crow Indians—Ethnographical History, with Remarks on the Grammatical Structure of their Language; XVII. Vocabulary of the Aub-sá-ro-ke, or Crow Language; XVIII. Minnitarees—Ethnographical History and Vocabulary; XIX. Mandans—Ethnographical History; XX. Observations on the Grammatical Structure of the Mandan Language; XXI. Vocabulary of the Mandan Language; XXII. Sketch of the Omá-ha, and Iowa or Oto Indians, with Vocabularies.

Fifty copies of this memoir were printed at the author's expense, which he desires to dispose of at two dollars per copy. Those desiring the work can obtain it by addressing Prof. S. F. Baird, Assistant Sect. Smithsonian Institution, Washington, D. C.

3. *Transactions of the American Philosophical Society*, held at Philadelphia, for promoting useful knowledge. Vol. xii, new series. Parts I and II, pp. 461. Philad., 1862.—The contents of this volume are,

Article I. On the Geology and Natural History of the Upper Missouri; with a map. By F. V. Hayden, M.D. pp. 1–218.

II. Experiments and observations upon the Circulation in the Snapping Turtle (*Chelonura serpentina*), with especial reference to the pressure of the blood in the arteries and veins. By P. Weir Mitchell, M.D. pp. 219–230.

III. On the Ethnography and Philology of the Indian Tribes of the Missouri Valley; with a map and plates. By F. V. Hayden. M.D. pp. 231–461.

It will be seen from the above titles that much of the substance of this volume has already appeared in this Journal in the various papers of Dr. Hayden which we have published. The Philosophical Society well maintains the objects for which it was founded, "for promoting useful knowledge."

4. *Annual Report of the Board of Regents of the Smithsonian Institution for* 1861: Washington, D. C., 1862. 8vo, pp. 463.—In his Report to the 'Board' as Secretary of the Smithsonian, Prof. Henry remarks:

"It could scarcely be expected that during the existence of an intestine war, and almost in the presence of two contending armies, the Institution should be able to conduct its affairs with the same persistence and success as in the tranquil years of its previous history. The interruptions and embarrassments, however, although frequent, and in some cases perplexing, have not prevented the continuance of the general operations of the Institution, or the prosecution of most of the special objects which had previously been determined upon as falling within the scope of the plan of its organization."

However this may be we are struck in examining this report with its great interest as a record of the progress of science as well as an index of the value of the important achievements made by the Institution itself in furtherance of the benificent design of its founder to "increase and diffuse knowledge among men."

The Report of the Secretary addressed to the Regents, reviews the present condition of the fund, the income of which has been diminished by non-payment of interest on about $60,000 of bonds of disloyal states, while a substantial addition to the fund has occurred of about $25,000 from the falling in of an annuity heretofore paid to a relative of Smithson, now deceased. While the active operations of the Institution will not be curtailed by the existing state of civil war, no new undertakings of magnitude will at present be begun. The Secretary, as is his custom, reviews the contents of the publications of the Institution for the year, giving an analysis of the concluding paper, discussing the results of Dr. Kane's Arctic observations, and of a series of papers on the meteorological observations made during the voyage of Sir F. L. McClintock in search of Sir John Franklin in the Fox—1857–1859. These papers form part of the XIIIth volume of the "Contributions."

The *Miscellaneous Collections* include works intended to facilitate the study of the various branches of natural history, to give instruction as to the methods of observing natural phenomena, and a variety of other matter connected with the progress of science. Very properly, in view of its great value as a key to the accurate study of Geology, the Smithsonian has published a series of valuable works on Conchology. They are five in number, as follows, viz.:

1st. Elementary introduction to the study of conchology, by P. P. Carpenter, of England.

2d. List of the species of shells collected by the United States exploring expedition, by the same author.

3d. Descriptive catalogue of the shells of the west coast of the United States, Mexico, and Central America, by the same author.

4th. Bibliography of North American conchology, by W. G. Binney.

5th. Descriptive catalogue of the air-breathing shells of North America, by the same author.

The Secretary announces that the illustrations presented from the wood cuts of the British Museum Catalogue by Dr. Gray, and designed to illustrate Dr. Carpenter's Elementary introduction, are now ready for distribution to all who have the work in a separate form.

The Smithsonian is also engaged in developing the history of American Entomology in a thorough and systematic manner, the details of which are given in the Secretary's report.

Ethnology also receives particular attention and a large number of collaborators are engaged in working up this department of knowledge on which indeed the earlier volumes of the Contributions are particularly full.

The system of meteorological observations inaugurated by the Smithsonian at the outset of its career is still maintained and the 2d volume of the Observations is nearly ready to be issued. The state of war has seriously impaired the receipt of records from the states in rebellion and to a good degree too broken up the system of returns from the military posts of the Pacific coast.

The magnetic instruments sent to Key West have been constantly observed and the photographic records uninterruptedly kept up in spite of their nearness to the seat of war, at the joint expense of the Smithsonian and Coast Survey.

Under the heads of Laboratory, Explorations, Collections of Natural History, Museum, Exchanges, Literary, Gallery of Art, and Lectures, valuable information is given for which unfortunately we have not space.

Since the rendering of the last report two of the Regents have died and the present volume contains eulogies on Prof. C. C. Felton by Dr. Woolsey of Yale College, who was elected his successor, and also on Hon. Stephen A. Douglass by his successor Hon. Samuel A. Cox, of the House of Representatives of the United States.

The General Appendix contains a number of voluable memoirs, some of them prepared for the Report by their authors, others translated from the French or German. These are preceded by an abstract of the Lectures given before the Institution, by their authors. We subjoin the contents of this Apppendix.

Lectures.—On the Construction of Bridges, by Prof. F. Rogers. On the Relations of Time and Space, by Prof. S. Alexander. On Arctic Explorations, by Dr. I. I. Hayes.

Memoir of Geoffroy Saint Hilaire, by M. Flourens.*

The Sun: Its Chemical Analysis, by Auguste Laugel.

Progress of Astronomical Photography, by Dr. Lee.

Small planets between Mars and Jupiter, by Prof. Lespiault.*

Scintillation of the stars, by C. H. Dufour.

Synthetical Studies and Experiments on Metamorphism and on the formation of Crystalline Rocks, by M. Daubrée; translated for this Report by T. Eggleston.

Report on Nitrification, by Dr. B. F. Craig.

Notes on the history of Petroleum or rock oil, by T. Sterry Hunt.

Explosibility of coal oils, by Z. Allen.

Destructive effect of iron rust.

Archæology.—Lacustrian Cities of Switzerland. Fauna of Middle Europe during the Stone Age. Report upon the Antiquarian and Ethnological Collections of the Cantonal Museum at Lausanne. Report to the Commissioners of the Museums of the Canton of Vaud on the Researches made at Concise. Ancient Mounds at St. Louis, Missouri. Instructions

* Translated for this Report by C. A. Alexander.

for Archæological Investigations in the United States. Circular on the Ancient Mining Operations of the Lake Superior Copper Region. Suggestions relative to an Ethnological Map of North America.

Natural History.—List of Birds of the District of Columbia, by E. Coues and D. W. Prentiss.

Prize Questions of Scientific Societies.—Holland Society of Science at Harlem. Batavian Society of Experimental Philosophy at Rotterdam. Society of Arts and Sciences at Utrecht. Royal Academy of the Netherlands.

We have to thank Prof. Henry for bringing together for convenient reference the lists of Prize Questions of scientific societies. We do not know where else to look for this information at one view and beg leave to suggest to the distinguished Secretary of the Smithsonian that this list be continued in future Reports and *extended* to embrace a yearly list of *all the prize questions* tending to the advancement of knowledge (not merely 'science' in a technical sense) which may be proposed anywhere. We know of no more acceptable service which the Institution can perform. We give in this connection a passage from a letter of a valued correspondent who speaking on this subject says:

"It is now far from easy for any one who may happen to live outside of the respective bailiwicks of the societies in question to ascertain what premiums are offered even by such prominent bodies as the Royal Society or the French Academy, while the programmes of many active societies like the Soc. d'Encouragement, the Soc. Industrielle de Mulhouse, and several of the other provincial societies of France, together with many in Germany, are certainly not known to one in a hundred of the persons competent, and likely to contend for, the proffered prizes. A remark which would also probably be nearly true with regard to some of our American prizes—like the Rumford medal, for discoveries in light and heat, of the American Academy; if not others like the medical premiums of Fiske and Boylston.

The offer of prizes is important not only in affording an incentive to laudable ambition, in tending to bring out talent and labor which would otherwise lie dormant and be lost to mankind, but the more especially, as it seems to myself, in affording indications to young experimenters of the paths to be chosen,—of the subjects to be worked upon, by them. For the questions are propounded, for the most part, by committees composed of trained specialists,—of eminent men peculiarly fitted to point out the actual desiderata of the branches of science or art with which they are occupied.

Having always believed that a prominent reason why several of the prizes in question have been so seldom taken is to be sought for in the lack of publicity which has attended their announcement, I am especially desirous of seeing a trial of the plan just proposed, during a decade or two at least. I cannot but believe but that it would prove to be a valuable aid to the progress of science.

5. *Journal of the Academy of Natural Sciences of Philadelphia.* New series, Vol. V, Part II. Philadelphia: printed for the Academy, Oct., 1862. 4to, pp. 111–216, with 33 plates.—The contents of this part are:

Art. III. Monograph of the fossil Polyzoa of the Secondary and Tertiary Formation of North America. By William Gabb and G. H. Horn, M.D.

Art. IV. Description of new birds from Western Africa in the Museum of the Academy of Nat. Sci. of Philadelphia. By John Cassin.

Art. V. New Unionidæ of the United States and Arctic America. By Isaac Lea.

The Academy of Natural Sciences nobly maintains its prominence among the publishing Societies of the United States, surpassing them all in the beauty of its quarto Journal and of the numerous plates with which its articles on natural history are illustrated. We are particularly struck with the drawings (on stone by Ibbotson from Gabb's originals) illustrating the fossil Polyzoa, which for perfectness have not been surpassed.

We are reminded by the appearance of Mr. Lea's paper in this Part of our neglect to notice at the time of its arrival his—

—4. *Observations on the genus Unio, &c.;* by ISAAC LEA, LL.D., &c., with 18 Plates, Vol. VIII, Part II, Feb., 1862, read Nov. 12, 1861, pp. 57–115. Mr. Lea's papers on the Unionidæ and other fresh water genera are too well known by all students of malacology to require any extended notice at our hands. As far back as March, 1860, Mr. Lea stated (*Proc. Phil. Acad.*, March 13, 1860) that the number of species described or known to exist in this department was as follows: Unio 465, Margaritana 26, Anodonta 59 = 550, to which he added as not yet described in his own cabinet 30; and for North America, known to inhabit Mexico, Honduras, Central America, and *one* in Canada—Unio 29, Anodonta 8 = 37, making the grand total at that date 617. Since then he has added the contents of the two papers now noticed.

OBITUARY.

Death of General O. M. MITCHEL.—Science mourns the sudden death, by yellow fever, of the patriot-soldier and eminent scientist, Major General ORMSBY MCKNIGHT MITCHEL, which occurred at Beaufort, S. C., on the 30th of October.

He had just entered, with his accustomed zeal and energy, upon the arduous duties of this difficult Military Department, when he fell a sacrifice to that fearful scourge, the general absence of which among our armies on the southern coast has been among the most noticeable hygienic facts of the campaign.

General (Prof.) Mitchel was born on the 28th of August, 1810, in Union County, Kentucky. His early life was checkered; and his love of learning made the boy the father of the man, even before the period of adolescence. He graduated as a cadet at West Point Military Academy in 1829, where he served for two years after, as Assistant Professor of Mathematics. He subsequently studied and practiced law in Cincinnati, and in 1834 accepted a chair of mathematics and astronomy in the Cincinnati College, which he held until 1844. He aided the development of the Railway system of Ohio, by constructing two of the most important lines of Railway in that State.

"The Cincinnati Observatory owes its existence to the labors of Prof. O. M. Mitchel. In the years 1841 and 1842, a society was organized in Cincinnati, called the Cincinnati Astronomical Society, the object of which was to furnish the city with an observatory. Eleven thousand dollars were subscribed in shares of twenty-five dollars; and a site for the observatory was given by Nicholas Longworth, Esq. It consists of four acres of ground, on one of the highest hills on the eastern side of the town. In June, 1842, the society being fully organized, Professor

Mitchel visited Europe to purchase a telescope. At Munich, he found an object glass of twelve inches aperture, which had been tested by Dr. Lamont, and pronounced one of the best ever manufactured. This was subsequently ordered to be mounted, and was purchased for $9,437. This instrument arrived in Cincinnati in February, 1845. In November, 1843, the corner-stone of the observatory was laid by the venerable John Quincy Adams. The building is eighty feet long and thirty feet broad."*

Here, as Director, he afterwards perfected his well known system of Astronomical Observations, and published for a time the *Sidereal Messenger*, the first exclusively Astronomical Journal in the United States. His method of recording right ascensions and declinations by aid of electro-magnetism, to within $\frac{1}{100}$th of a second of time, is well known to astronomers. He devoted much time to the determination of the velocity of the magnetic current in a long series of transit measurements for differences of longitude in connection with the U. S. Coast Survey. He remeasured Struve's double stars south of the equator, resolving many not before marked as double or triple. The exact period of rotation of Mars and the companion of Antares are also among his discoveries. He retained connection with this Observatory to the last; while in 1859 he was also made Director of the Dudley Observatory at Albany. His "Planetary and Stellar Worlds" and his "Popular Astronomy" are among the best known of his writings.

Probably no discourses on so abstruse a science as astronomy ever created such an impression on the public mind, as his well remembered lectures in 1859 in the N. Y. Academy of Music, where by the vividness of his descriptions—using no diagrams but such as he described in the air by a wand—he held vast audiences in the most wrapt attention, unaided by any of the usual accessories of scientific demonstration. The same impassioned eloquence moved his hearers, when the peril of his country, led him to abandon the Observer's chair and his equatorials to direct armies. The record of his remarkable military exploits belongs elsewhere. Suffice it to say that dying he leaves a record as brilliant in arms, as has been his career in other and more peaceful pursuits.

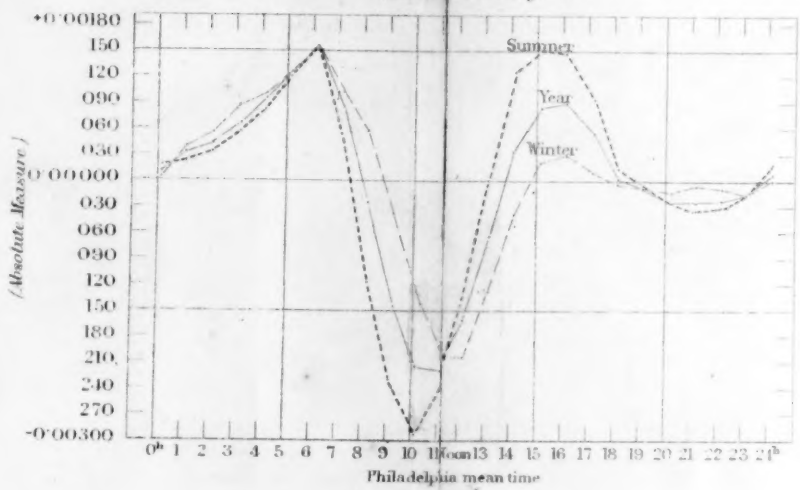
Newton Spaulding Manross.—We have also to record the loss by this war of another of our respected collaborators whose name has often appeared in these pages—Newton Spaulding Manross, Ph.D., acting Professor of Chemistry at Amherst, was killed in the battle of Antietam, September 17th, while gallantly leading a charge at the head of his company in the 16th Connecticut Volunteers.

Dr. Manross was a graduate of Yale College in 1849, and took the degree of Doctor of Philosophy at Göttingen in 1852. Geology and mining engineering were his special pursuits. He has been much occupied in the exploration of the Isthmus of Panama with reference to the proposed section of that neck of land by an interoceanic canal. His description of the Pitch lake of Trinidad, which he visited in 1855, will be found in vol. xx, p. 153 of this Journal. His Inaugural Thesis 'on the Artificial Production of Minerals' will also be recalled for its merits.

* Loomis's History of Astronomy in the United States, p. 452.

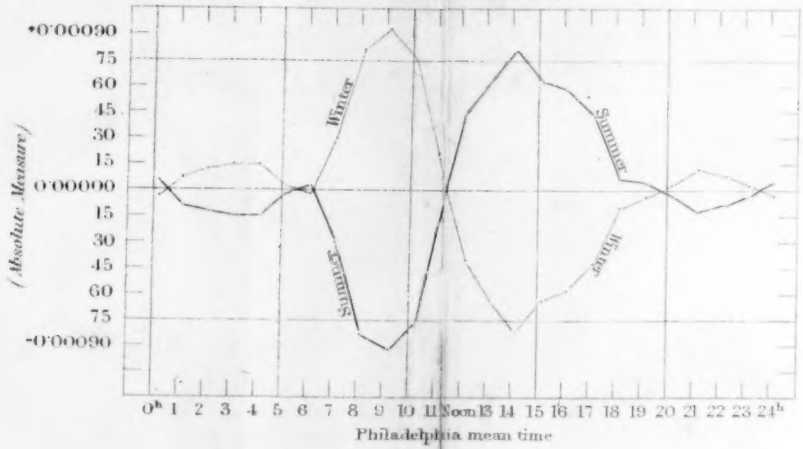
A

Diurnal variation of the Horizontal force in Summer Winter and for the whole year

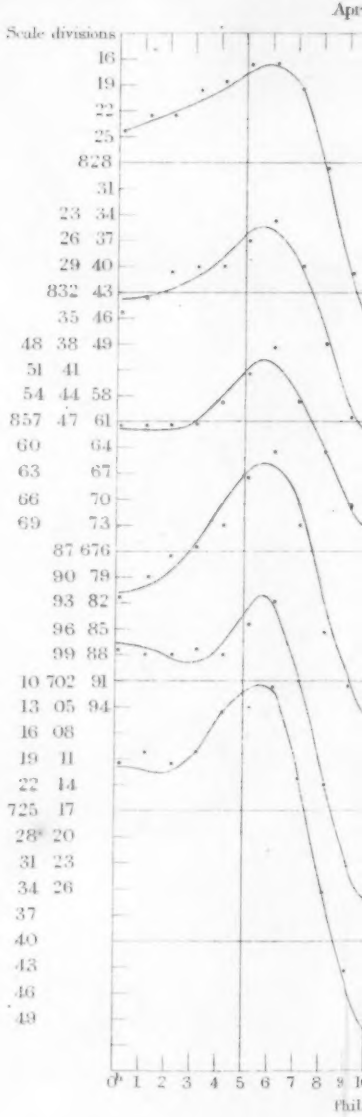


B

Semi-annual inequality in the diurnal variation of the Horizontal force



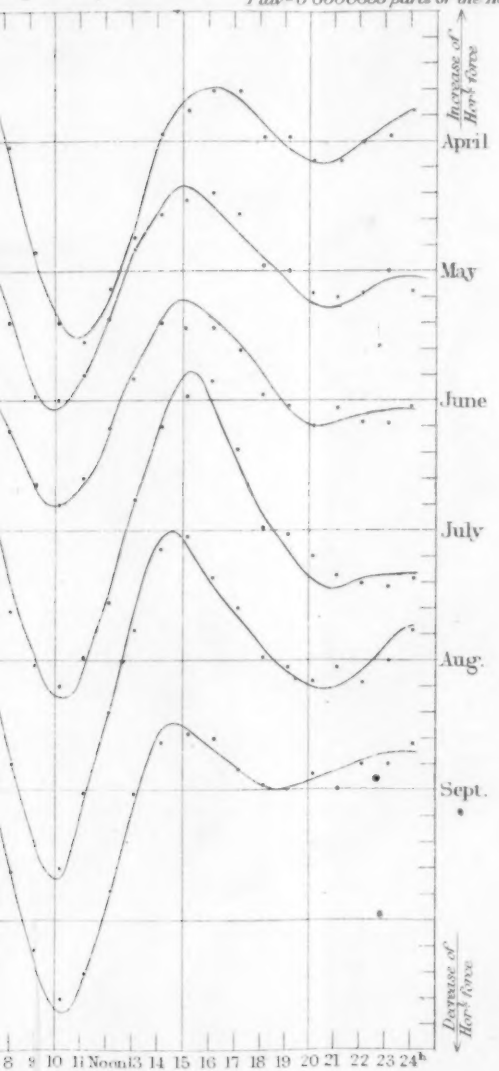
Solar-diurna
Apr



C

urnal variation of the Horizontal force
April to Sept. 1840 to 1845

1 div.=0·0000365 parts of the Hor.l force

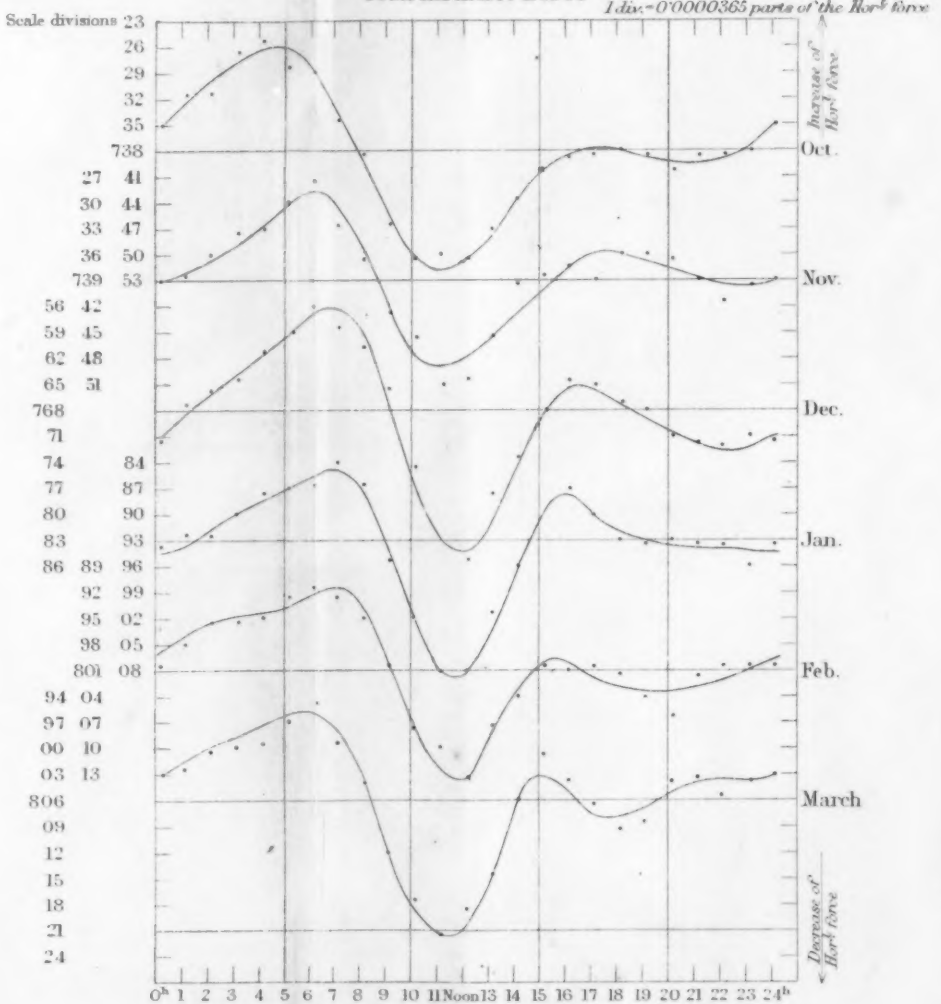


Philadelphia mean time

D

Solar-diurnal variation of the Horizontal force
Oct. to March 1840 to 1845

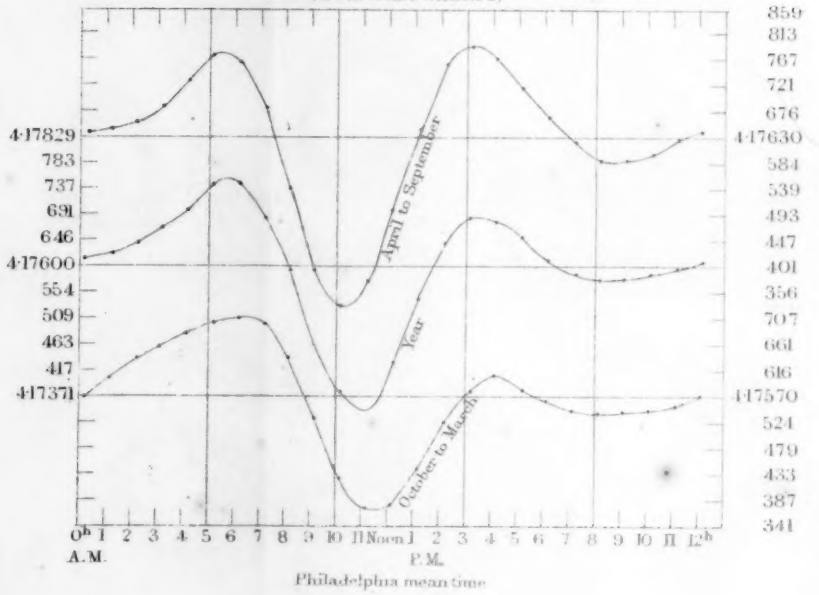
1 div.=0·0000365 parts of the Hor.l force



Philadelphia mean time

E

Regular Solar-diurnal variation of the Horizontal force
in Summer Winter and the whole year
(In absolute measure)



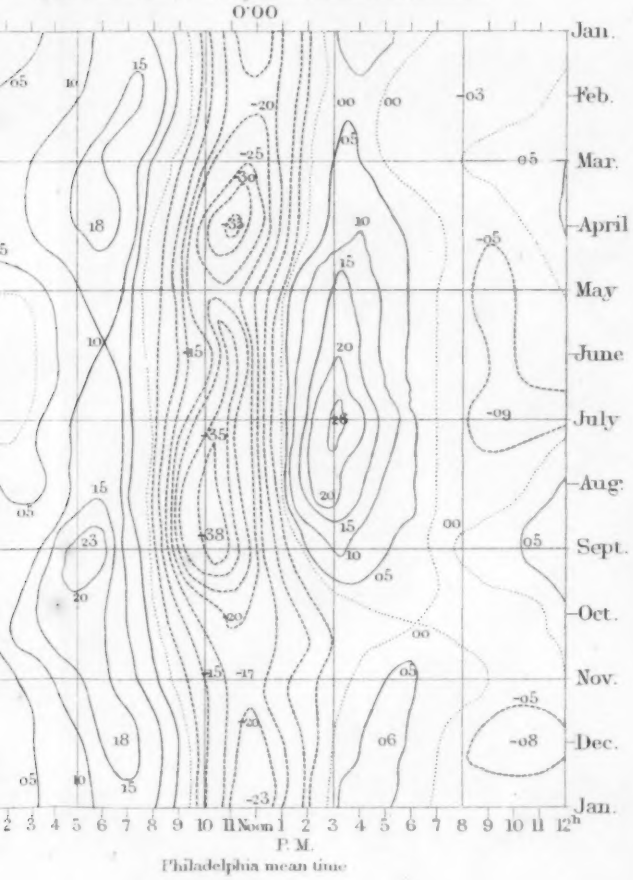
Philadelphia mean time

Changes of

(Continued)

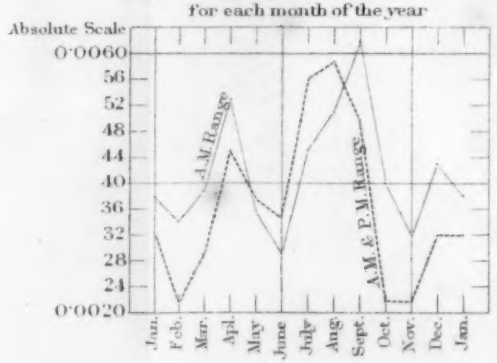
G

s of the Horizontal force from it's normal value for each hour of the day and month of the year. Expressed in absolute measure



F

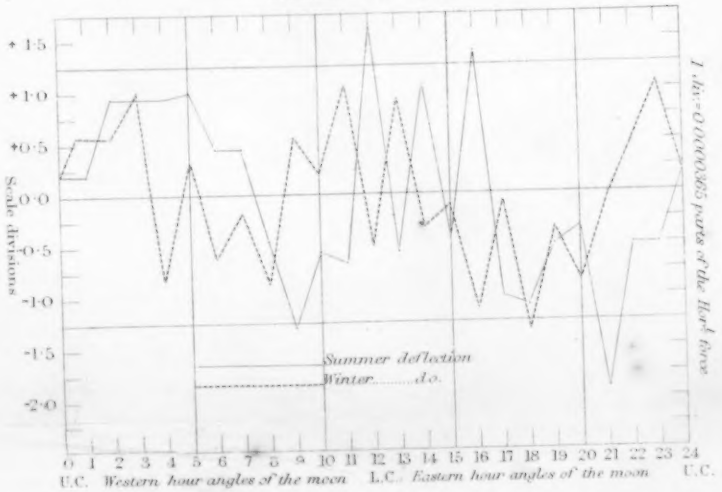
Solar-diurnal range of the Horizontal force for each month of the year



DIAGRAMS TO PART VI.
1862

A

Lunar-diurnal variation of the Horizontal force
in Summer and Winter


+1·5
+1·0
+0·5
0·0
-0·5
-1·0
-1·5
-2·0
Scale divisions
1 division = 0·000365 parts of the Hor.l force
Summer deflection
Winter.....d.o.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
U.C. Western hour angles of the moon L.C. Eastern hour angles of the moon U.C.

B

Lunar-diurnal variation of the Horizontal force
observed and computed

RVATIONS MADE AT THE GIRARD COLLEGE PHILADELPHIA

A.D. BACHE LL. D. SUPERINTENDENT

B

Lunar-diurnal variation of the Horizontal Force

observed and computed

Index photographed at the
beginning for the convenience
of the microfilm user.